THE BEHAVIOUR OF STYLE ANOMALIES IN WORLDWIDE SECTOR INDICES:

A UNIVARIATE AND MULTIVARIATE ANALYSIS

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Abstract

The aim of this thesis is to explain the cross-section of International Classification Benchmark (ICB) level 4 (sector) index returns. A worldwide study of 48 developed and emerging countries is conducted, considering up to 38 sector indices per country. In cluster and factor analyses of the sector returns all the developed markets are found to cluster together, as are the emerging markets, suggesting diversificationary benefits from investing across the two. The one-month-ahead return forecasting power of 35 sector-specific attributes is investigated over an in-sample period from 31 January 1995 to 31 December 2001 and an out-sample period from 31 January 2002 to 31 December 2005. The data is adjusted for look-ahead bias, outliers, influential observations and non-uniformity across markets. Monthly sector returns are cross-sectionally regressed on the attributes in a similar fashion to Fama and MacBeth (1973). Sector returns are considered both before and after risk adjustment with the Capital Asset Pricing Model (CAPM), the Arbitrage Pricing Theory (APT) model and Solnik's (2000) version of the International CAPM (ICAPM). The ICAPM is found to be the best performing model but, in general, the evidence does not support covariance-based models of asset pricing. Nine attributes are found to be significant and robust over the two sample periods namely cash earnings per share to price (CP), dividend yield (DY), cash earnings to book value (CB), 6 and 12-month growth in cash earnings, to price (C-6P & C-12P), 12 and 24-month growth in dividends, to price (D-12P & D-24P), the payout ratio (PO) and 12-month prior return (MOM-12).

All the significant attributes from the univariate regression tests are found to pay off consistently in the positive direction when tested with the nonparametric Sign Test. Nine of the significant attributes namely book value per share to price (BP), dividend yield (DY), earnings yield (EY), 6-month growth in cash earnings, to price (C-6P), cash earnings to book value (CB), 24-month growth in dividends, to price (D-24P), 24-month growth in earnings, to price (E-24P), 12-month and 18-month prior return (MOM-12 & MOM-18) are also found to have significantly low frequencies of changes in payoff direction when assessed with the nonparametric Runs Test. Seven style timing models are developed, all of which produce significantly accurate payoff direction forecasts for most of the significant attributes. The timing models are however generally inaccurate in forecasting the magnitude of the payoffs. Very little seasonality is observed in the payoffs to the significant attributes. Two sets of seven 'stepwise optimal' and 'control' multivariate models are constructed from the significant univariate in-sample attributes in order to forecast the payoffs to the factors in a controlled multifactor setting. The stepwise optimal models are derived from a stepwise procedure, whilst the 'control' models comprise all the attributes which are found to be significant in one or more of the 'optimal' models. The forecasting power of the all the models is found to be below an exploitable level; of the 'control' models the single exponential smoothing model is the most accurate out-sample performer. Weighted Least Squares (WLS) models are used to allow for the possibility of heteroskedasticity, which may exist in the cross-section of worldwide sector returns. The WLS models are ineffective in improving forecasting power when the inverse of the 12-month rolling standard deviation of the residuals is used as the weight series.

Declaration

I, Daniel Acres, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other University. I empower the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signed by candidate

Daniel N.G. Acres

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Introduction

"There is an exact linear relationship between expected returns and true 'betas' when the market portfolio is on the ex ante mean-variance frontier, but empirical research has found little relation between sample mean returns and estimated betas. A possible explanation is that market portfolio proxies are mean-variance inefficient."

-Roll and Ross (1994, p.101)

1.1. Introduction and Aim of the Study

Contemporary financial theory has seen the development and evolution over the last half century of numerous asset-pricing models including the Sharpe (1964), Lintner (1965), Mossin (1966) and Black (1972) Capital Asset Pricing Model (CAPM) and Solnik's (2000) version of the International CAPM (ICAPM). However, in general, covariance-based models have been shown to be empirically weak (see Roll and Ross, 1994) and in many cases so-called 'style anomalies' have proved more effective at explaining the return-generating process of ordinary shares. Practitioners and academics have typically grouped attributes, which indicate similar characteristics within a firm and these have lead to various share classification being made, for example 'value' and 'growth' stocks. Style-based investing has developed on the strength of stock performance within the relevant 'style' groups. To the author's knowledge very little work has been done in assessing the benefits which accrue to style-based investing at a sector level on a worldwide basis. As a result, the primary aim of this study is to reveal certain sector-specific attributes, which are able to explain the cross-section of sector returns beyond the ability of the CAPM, ICAPM and Arbitrage Pricing Theory (APT) model in a worldwide setting.

Section 1.2 reviews the motivation for this research and the resultant objectives of the study whilst section 1.3 outlines the thesis organisation and section 1.4 discusses the contribution to the literature.

1.2. Motivation for the Research and Objectives

Much debate has arisen in the literature as to the level of integration of the world financial markets, the varying levels of correlation in bull and bear markets and thus the benefits of international diversification. In a truly integrated world market, it would be expected that sector returns could be modelled in terms of a world market portfolio, which would be held by all investors in varying proportions to some risk-free asset, with the proportions being contingent on their level of risk aversion. The influence of currency fluctuations on foreign investments necessitates a mechanism for the partial or complete hedging of currency exposure. In a more segmented world market, sector returns would be better modelled in terms of country-specific market portfolios or perhaps developed and emerging market portfolios depending on the level of integration.

The above debate gives rise to the first objective of this study, that being to assess which asset-pricing model is most suitable for modelling worldwide sector level returns: the Single-Index model, the empirically testable ICAPM or the Multi-Index model. The Single-Index model, by construction, assumes that investors are completely un-hedged in terms of currency exposure, whilst the empirical ICAPM allows full or partial hedging by modelling the exposures of the portfolio to various currencies.

The second objective of the study is to investigate the cross-sectional relationship between worldwide sector returns and sector-specific attributes both before and after CAPM, ICAPM and APT-based risk adjustment. Furthermore, the study aims to investigate whether or not the returns to the sector-specific attributes are robust to varying time periods and remain significant out-of-sample.

Evidence has been presented in the literature to suggest that the payoffs to certain styles are at times inconsistent and in some cases, such as the 'size' effect, reversals in the payoff direction have been seen over time (see Dimson and Marsh, 1999). In light of these findings, the third objective of this study is to investigate the behaviour of the payoffs to the sector-specific attributes in terms of consistency and timing and ascertain whether or not the payoffs can be predicted.

Many studies have identified seasonal trends in the payoffs to specific attributes, the most thoroughly researched of which is probably the 'January' effect. However, other seasonal effects have been identified in various countries and thus the fourth objective of this study is thus to investigate seasonality in the attribute payoffs and isolate seasonal trends.

The fifth and final objective of this study is to conduct multivariate cross-sectional regression analyses to derive various multivariate forecasting models and assess their accuracy and viability in terms of return forecasting power.

1.3. Thesis Organisation

Chapter two presents a theoretical overview, which begins by quantifying the concept of information efficiency and in light of this, explains the varying degrees of market efficiency. It then proceeds to describe the mechanics behind mean-variance analysis and portfolio selection as well the CAPM and the joint-hypothesis problem. International market efficiency is then discussed and the ICAPM is presented. Finally the multifactor APT model is discussed.

Chapter three reviews the existing literature pertinent to this study. It opens with evidence for and against market efficiency and then discusses the views for and against the CAPM. Empirical deviations from the CAPM are discussed from both a risk-based and non risk-based perspective. Evidence for and against the ICAPM and global risk diversification is then presented. Finally statistical and structural methods are compared and contrasted as methods for picking the factors in an APT model and style anomalies are discussed.

Chapter four deals with the data used in the study: it discusses the statistical biases which can arise in the data, the market and sector returns data, the sector-specific attribute data and the adjustments which are made to the data to avoid bias. The attributes are then presented along with their respective codes and formulae for construction. Finally, the descriptive statistics for the attribute data are presented.

Chapter five involves an exploratory analysis of the data and risk decomposition. Under the explanatory analysis, cluster analysis and factor analysis using the principal components methodology of the various market indices as well as the world, developed and emerging markets indices are conducted. Under the risk decomposition, three asset-pricing models are constructed and tested, namely the Single-Index, empirical ICAPM and Multi-Index models.

Chapter six presents the univariate cross-sectional regression analyses of the sector returns on the sector-specific attributes. Both unadjusted returns and risk-adjusted returns (using the three asset-pricing models from chapter five) are used and highly correlated attributes are identified. The payoffs to the various style groups are also displayed and the time period specificity assessed over the in and out-sample periods.

Chapter seven involves a style consistency assessment of the payoffs to the sector-specific attributes as well as an assessment of style momentum. It then presents seven style timing models and evaluates their effectiveness in forecasting payoff direction and magnitude.

Chapter eight deals with seasonality in the payoffs to the sector-specific attributes. Michaud's (1999) t-tests by exclusion are used in conjunction with both nonparametric and parametric methods to identify seasonality in the monthly payoffs. Scheffé (1953) contrasts are then used in an attempt to pinpoint the months responsible for the seasonality.

Chapter nine presents the multivariate cross-sectional regression analyses of the sector returns on the sector-specific attributes. The regression coefficients are the controlled payoffs to the individual attributes in a multifactor environment. The cumulative controlled payoffs are presented and style timing is again assessed. Two sets of forecasting models are developed using seven forecasting techniques. The 'stepwise optimal' models and the 'control' models are then evaluated and reconstructed using weighted least squares estimates for the coefficients to combat heteroskedasticity in the cross-section of returns.

Chapter ten summarises the results from chapters five to nine, concludes the thesis and finally suggests further areas for research in relation to the topic.

1.4. Contribution

The main contributions of this study to the literature fall in the fields of market efficiency, the effectiveness of asset-pricing models, international diversification and international style-based investing at a sector level.

Fama (1991) revises his previous 1970 classifications of tests for market efficiency from tests for weak, semi-strong and strong form efficiency to tests for return predictability, event studies and tests for private information. A contribution is made to the tests for return predictability as this study considers the explanatory and forecasting power of sector-specific attributes both before and after risk adjustment with the CAPM, ICAPM and APT models. Furthermore the tests are conducted at a sector level where the literature is fairly sparse as opposed to at a firm level where considerably more work has been done. Significant payoffs to sector-specific attributes after risk adjustment indicate that the either the asset-pricing model under consideration has been misspecified or the markets under consideration are inefficient / segmented or both.

To the author's knowledge this study tests the most sector-specific attributes yet constructed at a sector level over the largest possible sample of countries. As such it makes a substantial contribution to the existing work in this field. Solink's (2000) ICAPM model is applied for the first time at a sector level in a country sample which includes not only developed but also emerging markets. Similarly, van Rensburg and Slaney's (1997) methodology of deriving observable APT model factor proxies through factor rotation is applied at a sector level in a worldwide setting for the first time. Furthermore, the study contributes considerably to the fields of style timing and seasonality within styles at a sector level, where the existing literature is again very thin.

Data snooping could be of concern given the number of attributes under consideration: spurious relationships can arise simply by chance if no *a priori* economic rational is presented for selecting a given significant attribute. Lo and MacKinlay (1990) are proponents of this criticism, suggesting that sample-specific significant attributes are bound to arise if enough variables are tested. Grinold and Kahn (1995) suggest that the selection of factors should be intuitive and done without analysing the data. In rebuttal to these criticisms of the methodology it must be said that many style effects are as yet not adequately explained and therefore have little economic justification but are still well documented and substantial (see literature on the 'size' and 'January' effects in sections 3.8.1 and 3.8.2.1, respectively). It is thus argued that the study would add less value by not testing those sector-specific attributes, which *as yet* have no economic rational for being tested than if a comprehensive list of attributes was tested.

'Value', 'growth', 'momentum', 'size and liquidity' and 'risk' attributes are assembled and tested in order to exploit any relevant financial information that they may contain. Further to supporting the misspecification of existing asset-pricing models it can be argued (see Fama and French, 1992, 1993, 1996) that anomalous effects are in fact proxies for risk factors, which are as yet unobservable.

The construction of various multivariate forecasting models not only contributes to the academic literature on efficient markets but also contributes to the tools and techniques which should be considered in active portfolio management.

-2-

Theoretical Overview

"... one can say that efficiency must be tested conditional on an asset-pricing model or that asset-pricing models are tested conditional on efficiency ... given the joint hypothesis problem, one can't tell whether ... anomalies result from misspecified asset-pricing models or market inefficiency."

-Fama (1991, p.1589)

2.1. Introduction

This chapter reviews the theory of information efficiency and asset pricing. Practitioners attempt to employ this theory in contemporary financial markets in order to generate superior risk-adjusted returns, whilst academics use the theory in an attempt to further understand the mechanisms that drive markets and the resultant observed asset prices and realised returns.

Information efficiency and asset pricing are reviewed in unison because they are intrinsically linked: any test of an asset-pricing model is also a test of market efficiency. Consequently, insignificant test results could imply an inefficient market or an incorrectly specified model or both.

The theory here reviewed, contextualizes the empirical results of the later chapters, with section 2.2 discussing information efficiency, section 2.3 discussing asset-pricing theory and section 2.4 summarising and concluding.

2.2. Information Efficiency

The degree of information efficiency in a market is the extent to which asset prices incorporate relevant information. Bachelier suggests that "...past, present and even discounted future events are reflected in market prices, but often show no apparent relation to price changes" (1900, p.84).

In his seminal paper on efficient capital markets, Fama develops his 'fair game' model and defines an efficient market to be "a market in which prices always 'fully reflect' available information" (Fama, 1970, p.383).

Fama (1970, p.384) posits that given a relevant information set, the equilibrium return on a security can be written as a function of its risk. Notationally, he proposes that:

$$E(\tilde{p}_{j,t+1} \mid \Phi_t) = [1 + E(\tilde{r}_{j,t+1} \mid \Phi_t)]p_{j,t} \tag{2.1}$$

Where E is the expected value operator

$p_{j,t}$ is the price of security j at time t

$p_{j,t+1}$ is the price of security j at time t+1 (with reinvestment of any intermediate cash income from the security)

$r_{j,t+1}$ is the single-period return $(p_{j,t+1} - p_{j,t})/ p_{j,t}$

Φ_t is a general symbol for the set of information which is assumed to be 'fully reflected' in the price at time t

~ is an indication that $p_{j,t+1}$ and $r_{j,t+1}$ are random variables at time t+1

Intuitively, the expected price of a security j at time t+1 is a function of the price at time t and the expected return over the time period from time t to t+1 (given the full set of relevant information at time t).

Fama's (1970, p.384) assumptions that the conditions of market equilibrium can be stated in terms of expected returns and that equilibrium returns are formed on the basis of (and thus 'fully reflect') the information set Φ_t, imply that trading systems based on the information in Φ_t will not yield returns and profits in excess of the equilibrium expected returns and profits. Thus let:

$$x_{j,t+1} = p_{j,t+1} - E(p_{j,t+1} \mid \Phi_t) \tag{2.2}$$

Where $x_{j,t+1}$ is the excess profit on security j at time t+1, then:

$$E(\tilde{x}_{j,t+1} \mid \Phi_t) = 0 \tag{2.3}$$

Hence, by definition, the sequence $\{\tilde{x}_{j,t}\}$ is a fair game with respect to the information series $\{\Phi_t\}$. Now let:

$$z_{j,t+1} = r_{j,t+1} - E(\tilde{r}_{j,t+1} \mid \Phi_t) \tag{2.4}$$

Where $z_{j,t+1}$ is the excess return on security j at time $t+1$, then:

$$E(\tilde{z}_{j,t+1} \mid \Phi_t) = 0 \tag{2.5}$$

Consequently, the sequence $\{\tilde{z}_{j,t}\}$ is also a fair game with respect to the information series $\{\Phi_t\}$.

Fama (1970, p.385) defines any trading system based on Φ_t, to be of the form:

$$\alpha(\Phi_t) = [\alpha_1(\Phi_t), \alpha_2(\Phi_t), ..., \alpha_n(\Phi_t)] \tag{2.6}$$

Where $\alpha_j(\Phi_t)$ are the funds available to be invested in any of the n securities at time t

Thus it can be inferred that the total excess market value V_{t+1} at time $t+1$, that will be generated by such a trading system is:

$$V_{t+1} = \sum_{j=1}^{n} \alpha_j(\Phi_t)[r_{j,t+1} - E(\tilde{r}_{j,t+1} \mid \Phi_t)] \tag{2.7}$$

The fair game property of (2.5) yields an expectation for V_{t+1} of zero, given the full set of relevant information at time t:

$$E(\tilde{V}_{t+1} \mid \Phi_t) = \sum_{j=1}^{n} \alpha_j(\Phi_t) E(\tilde{z}_{j,t+1} \mid \Phi_t) = 0 \tag{2.8}$$

Fama's (1970) work shows that regardless of the trading system chosen (as long as it is based on the full set of relevant information available at time t), the expected excess market value will always be zero, implying that prices fully reflect all available relevant information and that returns are consistent with the risk taken on.

2.2.1 The Random Walk and Submartingale Models

Fama (1970, p.368) mentions two special cases of the 'fair game' model, namely the 'random walk' and 'submartingale' models:

2.2.1.1. The Random Walk Model

Kendall (1953, p.11) pioneered the application of a random walk model to asset prices, suggesting that stock prices move randomly and cannot be predicted from their own past price behaviour or from other securities: "the data behaved almost like wandering series … stock exchange movements revealed little serial correlation within series and little lag correlation between series. Unless individual stocks behave differently from the average of similar stocks, there is no hope of being able to predict movements on the exchange …" (Kendall 1953, p.11).

By Fama's (1970, p.368) definition, share returns are said to follow a random walk if the conditional and marginal probability distributions are identical. Put notationally:

$$f(r_{j,t+1} \mid \Phi_t) = f(r_{j,t+1}) \tag{2.9}$$

The implications of share returns following such a model are that successive single-period returns are independent and identically distributed.

2.2.1.2. The Submartingale Model

Fama (1970, p.368) defines the submartingale model for share prices and returns by saying that the expected price in the next period, based on the full set of relevant information in the current period, is greater than or equal to the price in the current period; notationally:

$$E(\tilde{p}_{j,t+1} \mid \Phi_t) \geq p_{j,t} \tag{2.10}$$

The equivalent statement in terms of returns is simply that the return in the next period, given the full set of relevant information in the current period, is non-negative:

$$E(\tilde{r}_{j,t+1} \mid \Phi_t) \geq 0 \tag{2.11}$$

Fama (1970) uses the fair game model and its special cases, the random walk and submartingale models to empirically evaluate the Efficient Market Hypothesis (EMH). Furthermore he includes previous literature on the EMH from Bachelier (1900), Kendall (1953), Alexander (1961), Cootner (1964) and others, explicitly commenting on which of the three models the literature is based on and hence clarifying the strength and relevance of the findings.

2.2.2 Efficient Market Hypothesis

The EMH "is the hypothesis that security prices at any point in time 'fully reflect' all available information" (Fama 1970, p.388). The null hypothesis is severe and because of this Fama (1970, p.388) specifies three forms, or levels of market efficiency, which allow for the point at which information efficiency breaks down to be found.

2.2.2.1. *Weak Form Efficiency*

A market is weak form efficient if the current security price reflects the entire history of past prices, whereby security prices change at random and past prices contain no information with regards future changes.

Fama's (1970) tests of weak form efficiency draw predominately on the random walk tests in the literature, testing the hypothesis that successive price prediction errors (and hence stock returns) are serially independent, given the full set of relevant information at time *t*:

$$E(\varepsilon_{i,t+1,}\varepsilon_{i,t} \mid \Phi_t) = 0 \tag{2.12}$$

Fama's (1970) results indicate strong support for market efficiency at the weak form level.

2.2.2.2. *Semi-strong Form Efficiency*

A market is semi-strong form efficient if the current security price reflects not only the entire history of past prices but also all public information contained in the published financial reports.

Fama's (1970) tests of semi-strong form efficiency deal with the speed of price adjustment to new public information and essentially test the hypothesis that there is no expected price prediction error, given the full set of relevant information at time *t*:

$$E(\varepsilon_{i,t+1} \mid \Phi_t) = 0 \tag{2.13}$$

Fama's (1970) results at this level are weaker than those of the weak form tests but still indicate support for market efficiency in the semi-strong form.

2.2.2.3. *Strong Form Efficiency*

A market is strong form efficient if the current security price reflects all available information, both public and private.

Fama's (1970) tests of strong form efficiency deal with monopolistic or insider access to price forming information and test the hypothesis that price prediction errors are independent of any price forecasts made, given the full set of relevant information at time *t*:

$$E\left(\varepsilon_{i,t+1} \mid E(\varepsilon_{i,t+1} \mid \Phi_t)\right) = 0 \tag{2.14}$$

Fama's (1970) results at the strong form level are incomplete considering only corporate insiders and specialists with monopolistic access to price forming information. However, the EMH is well supported and Fama (1970, p.416) comments that "the evidence in support of the efficient markets model is extensive, and (somewhat uniquely in economics) contradictory evidence is sparse."

2.2.2.4. The Impact of Costly Information

Grossman and Stiglitz (1980) contest Fama's (1970) findings by building on the earlier work of Grossman (1975, 1977, 1978) and Grossman, Kihlstrom and Mirman (1977). Grossman and Stiglitz (1980, p.404) argue that price systems and competitive markets are only important when information is costly and that costly information is not only a *sufficient* condition for market equilibrium (as purported by the Efficient Market theorists) but a *necessary* one.

Through numerous conjectures (1980, p.394) and a general example (1980, p.395) Grossman and Stiglitz derive a model with an "equilibrium degree of disequilibrium" (1980, p.393), better known as the Grossman and Stiglitz paradox. The paradox can be reasoned as follows: if information were not costly then perfect information symmetry would arise in the market and security prices would reflect the commonly held information. However, the costly nature of information implies that any marginal gain from extra information must be balanced with the marginal expense of obtaining that information. Given that Efficient Market theory implies that a security's price fully reflects all available relevant information, investors have no incentive to gather information when they can simply infer it from the current price. However, if this is the case then no information would be gathered and the current price would instead reflect the information set of relevant information *not* collected. Succinctly put, the paradox is that "because information is costly, prices cannot perfectly reflect the information which is available, since if it did, those who spent resources to obtain it would receive no compensation" (Grossman and Stiglitz, 1980, p.405).

2.2.2.5. Redefining Market Efficiency

In Fama's (1991) sequel on Efficient Capital Markets he redefines the three levels of market efficiency. He expands (1991, p.1576) weak form efficiency to 'tests for return predictability', so as to include the effect of anomalous factors (like those considered in this study), considering factors such as dividend yield, interest rates, size and seasonality. Semi-strong form and strong form efficiency are intuitively renamed to 'event studies' and 'tests for private information', respectively.

In reviewing the tests for return predictability, Fama (1991, p.1609) notes a shift in focus from short-run tests to tests with longer horizons. Short-run tests tend to exhibit positive autocorrelation whilst long-run tests appear to exhibit strong negative autocorrelation in the two to ten-year time horizon. In short, the implication is that "expected returns take large, slowly decaying swings away from their unconditional means" (Fama, 1991, p.1609).

The event studies indicate that "on average stock prices adjust quickly to information about investment decisions, dividend changes, changes in capital structure and corporate-control transactions" (Fama, 1991, p.1607). Fama thus supports the notion that prices adjust efficiently to firm-specific information.

The tests for private information are inconclusive, with single-factor models such as that of Ippolito (1989) supporting the generation of positive abnormal returns from insider information and multi-factor models such as those of Elton, Gruber, Das and Hlavka (1993) and Brinson, Hood and Beebower (1986) supporting negative abnormal returns generation on insider knowledge. Fama (1991, p.1608) notes that in truth, the joint hypothesis problem coupled with the weak state of evidence for different asset-pricing models (both discussed in section 2.3) prevent any strong inferences from being made with regards market efficiency, when those inferences are based on performance evaluation tests.

2.3. Asset Pricing Theory

In order to determine the efficiency of a given asset market, it must be possible to accurately and reliably model assets prices. As a result, the joint efficient market hypothesis has arisen: "The Theory [of Efficient Markets] only has empirical content … within the context of a … specific model of market equilibrium, that is, a model that specifies the nature of market equilibrium when prices 'fully reflect' available information" (Fama, 1970, p.413-414). Robertson's (2002, p.2.6) succinct interpretation is that "a model of asset prices is inseparable from an appraisal of asset market efficiency." In this context, asset-pricing theory is reviewed under the vices of mean-variance analysis and portfolio selection, the capital asset pricing model and arbitrage pricing theory.

2.3.1 Mean-Variance Analysis and Portfolio Selection

Markowitz (1952, p.77) divides the portfolio selection problem into two stages: firstly 'observing and experiencing', which leads to beliefs about the future performance of available securities and secondly 'choosing a portfolio' based on relevant beliefs. He ignores the first stage and sets about determining a sensible paradigm in which the portfolio investment decision can be made.

Maximizing the discounted value of expected future returns, is disregarded as a maxim for the investment decision because it does not support the sensible and observed practice of diversification. Instead, the hypothesis that efficient portfolios should maximize the investor's expected return at a given level of risk (variance) is adopted, as it supports diversification across a large and presumably representative range in the expected return-variance space (Markowitz, 1952, p.89). Put notationally, investors attempt to maximize their utility in the form of the following objective function:

$$U = U(\mu_p, \sigma_p^2) \tag{2.15}$$

Markowitz (1952) derives an efficient frontier for portfolio investment by considering the intersection of indifference curves, derived from the objective function at varying levels of utility, and the 'isomean' and 'isovariance' curves, derived from the universe of available of securities.

The most prominent implication of the paper is that investors can use mean-variance analysis to pick a diversified portfolio, which is both efficient and matches their required level of utility or risk aversion.

2.3.2 The Capital Asset Pricing Model (CAPM)

The CAPM is an equilibrium model of asset pricing, which was developed by Sharpe (1964), Lintner (1965), Mossin (1966) and Black (1972) by extending the mean-variance analysis of Markowitz (1952). The CAPM considers the entire market as opposed to an individual investor and consequently leads to several expected return-risk relationships, which involve a market portfolio: the Capital Market Line (CML) permits modelling of portfolio expected returns, whilst the Security Market Line (SML) permits modelling of individual security expected returns.

2.3.2.1. Derivation of the CAPM

The CAPM is derived on the basis of numerous assumptions, summarised below:

- There are many investors, each with a relatively small amount of wealth when compared to the total wealth of the market.
- Perfect competition prevails and as a result investors are price takers.
- Investors plan for one identical holding period and are concerned only with their terminal wealth. Portfolios cannot be rebalanced during this period.
- The investment universe is limited to that of publicly traded financial assets.
- Investors can borrow or lend any amount at a fixed, risk-free rate.
- Markets are frictionless in that investors pay no taxes on returns and no transaction costs.
- Investors are rational and only use Markowitz mean-variance analysis to maximise their utility. They are considered risk averse, preferring lower risk to higher risk and higher return to lower return.
- Investors have identical opinions regarding asset expected returns and covariances.
- Individual assets are infinitely divisible and as a result may be held in any proportion of the total portfolio.
- All assets are considered to be tradable at the observed market prices.

The assumptions lead to the Separation Theorem which implies a state of market equilibrium where all investors hold the market portfolio of risky assets. The market portfolio comprises all traded assets held in proportion to their market value. Equilibrium arises because investors have homogenous expectations and hence desire the same optimal risky portfolio. Market values are bid up or down until all investors hold all the risky assets in the same proportion i.e. until they hold the market portfolio.

Investors have varying degrees of risk aversion and adjust their level of risk exposure (and hence expected return) by holding varying amounts of a risk-free asset in combination with the market portfolio. The efficient frontier thus becomes a linear combination of the return on the risk-free asset and the return on the market portfolio. Two theoretical constructs are derived, namely the Capital Market Line (CML) and the Security Market Line (SML).

The CML models the expected return of a portfolio of risky assets:

$$E(r_p) = r_f + \frac{\sigma_p}{\sigma_m}\left[E(r_m) - r_f\right] \tag{2.16}$$

Where $E(r_p)$ is the expected return on the portfolio of risky assets

$E(r_m)$ is the expected return on the market portfolio

r_f is the risk-free rate of return

σ_p is the standard deviation of the portfolio of risky assets

σ_m is the standard deviation of the market portfolio

Standard deviation is used as the risk measure because by definition, an efficient portfolio such as portfolio p must be fully diversified and as a result non-systematic risk is diversified away. Investors are not rewarded for non-systematic risk because it can be diversified away in a portfolio and hence, when considering individual assets a different risk measure is required which, only takes account of systematic risk. Beta is such a risk measure; the beta for an asset i is defined as:

$$b_i = \frac{Cov(r_i, r_m)}{\sigma_m^2} \tag{2.17}$$

The SML uses beta to model the expected return of an individual risky asset i:

$$E(r_i) = r_f + b_i\left[E(r_m) - r_f\right] \tag{2.18}$$

The CAPM is limited in its practicality because of its restrictive underlying assumptions and reliance on a theoretical market portfolio. Nevertheless, these should not detract from its eminence as the first formal asset-pricing model of modern finance.

2.3.2.2. Empirical Tests using the Single-Index Model

The CAPM is an equilibrium model of expected returns. Expected returns are *ex ante* variables and cannot be observed *ex post*. Consequently, the Single-Index model is employed to test the predictive power of the CAPM by observing *ex post* realised returns.

In making the transition from the CAPM to the Single-Index model two further assumptions are required:

- An appropriate index can be found which is perfectly correlated with the unobservable market portfolio.
- Stock returns are stationary over time.

The Single-Index model can be expressed notationally as:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + \varepsilon_{i,t} \tag{2.19}$$

Where $r_{i,t}$ is the observed realised return on asset i at time t

$r_{m.t}$ is the observed realised return on the appropriate market index at time t

$r_{f,t}$ is the risk-free rate of return at time t

α_i is the excess systematic return on asset i, unaccounted for by beta

β_i is the sensitivity of the excess return on asset i to the excess return on the market

$\varepsilon_{i,t}$ is the unexplained residual return on asset i at time t

The error terms $\varepsilon_{i,t}$ are assumed to be independently, identically and normally distributed. The alpha term has an expected value of zero under the CAPM, since the model is supposed to account for all systematic risk. Under the Single-Index model, the observed value of α_i should average out to zero over the sample of historical observed returns.

2.3.2.3. The Joint Hypothesis Problem

In order to empirically test the accuracy of the CAPM it is necessary to construct or observe a market portfolio. Unfortunately, the market portfolio is a theoretical construct, which cannot be fully and accurately observed. As a result, broad-based equity indices such as the S&P500 in the USA are typically used to proxy for a market index. The result is that any empirical test of the CAPM thus becomes a test not only of the pricing model but also of the efficiency of the underlying proxy.

Roll's (1977) CAPM critique points out the implications of the joint hypothesis problem. Roll (1977) notes that the market portfolio is not only limited to equities but includes every tradable (such as bonds and property) and non-tradable (such as human and intellectual capital) asset. Roll (1977) argues that unless the market portfolio can be known with certainty, the CAPM can never accurately be tested. Insignificant beta coefficients in empirical testing can thus be attributed to either an incorrectly specified market portfolio or to a poor asset-pricing model, or to both.

2.3.3 International Market Efficiency

International market efficiency extends the concept of information efficiency within individual country markets to efficiency on a global scale. Solnik (2000, p.161) considers efficiency in terms of the two opposing concepts of 'integration' and 'segmentation'. He purports that a fully integrated world financial market would achieve international efficiency as capital would be free to flow across borders and instantaneously take advantage of any new information in the world market. Conversely, a segmented market would be inefficient with a variety of impediments to capital mobility resulting in similar assets in different countries being priced differently. Typical impediments include psychological barriers, legal restrictions, transaction costs, discriminatory taxation, political risks and exchange risks. Assessing the level of global market integration requires the formulation of a world market portfolio which must be tested in the guise of an asset-pricing model. As a result the joint hypothesis problem is again encountered: any test of market efficiency is also a test of the asset-pricing model used (see section 2.3.2.3 for more detail).

2.3.4 The International Capital Asset Pricing Model (ICAPM)

The ICAPM is simply an extension of the domestic CAPM (see section 2.3.2) to an international context where investors use different currencies and have different consumption preferences.

2.3.4.1. Derivation of the ICAPM

The derivation of the ICAPM, inline with the domestic CAPM, requires the following two additional assumptions, suggested by Solnik (2000, p.165):

- Investors throughout the world have identical consumption baskets.
- Real prices of consumption goods are identical in every country i.e. purchasing parity holds exactly at every point.

The above assumptions result in a paradigm where exchange rates simply reflect the inflation differentials between various countries and are merely conversion tools for converting from one currency to another, and it is irrelevant which currency is held or used. However, purchasing power parity has been shown repeatedly not to hold (see Solnik, 2000, p.44) and consumption preferences differ vastly among countries, resulting in a desire on the part of investors to hedge or partially hedge their foreign currency exposure.

Consequently, Solnik (2000, p.165) instead assumes that investors care only about returns in their home currency. Under the assumptions of the domestic CAPM, they are free to borrow and lend at the risk-free rate of interest in every country and hence hedge their currency risk exposure by replicating forward contracts. In other words, investors can borrow in a country in which they have invested and then convert the borrowed amount and invest it at home for the duration of the investment. On maturity of the investment (and by construction, the loan) they reconvert the loan into foreign currency and repay it, simultaneously disinvesting from the foreign country and reconverting to their own local currency.

According to Solnik (2000, p.165) investors use mean-variance optimisation to determine their demand for each asset, and the equilibrium nature of the model implies that the net borrowing and lending in each currency is zero. The Separation Theorem follows as a direct result: all investors hold a combination of the risk-free asset in their own country and the world market portfolio, partly hedged against currency risk. The partly hedged world market portfolio is the optimal portfolio for all investors because of their homogenous expectations and as a result, they all hold it, but in different proportions to the local risk-free asset, depending on their level of risk aversion. Solnik (2000, p.166) points out that the optimal hedge on each currency need not be a complete hedge against that currency and will differ according to the asset and currency under consideration.

The ICAPM is similar to the domestic CAPM in that the expected return on an asset is modelled in terms its covariance with the market index, but differs in that the relevant market risk is world market risk and not domestic market risk, and in that additional terms are required to capture the asset's covariance with the various exchange rates. The additional risk premia compensate the investor for currency risk that cannot be diversified away since currency movements affect all securities in the portfolio to some extent. Solnik (2000, p.166) points out that the ICAPM simplifies to the same form as the standard CAPM for an asset that is uncorrelated with the various exchange rates i.e. for an asset that is optimally hedged against currency risk. However, he further reasons (p.167) that although currency risk can be eliminated through hedging with forward contacts, the act of doing so results in an interest rate differential between the relevant countries, which is equivalent to the risk premium that would be paid in the absence of hedging. Consequently, this study considers the ICAPM in the absence of any hedging and considers a typical US investor who is investing abroad and is only concerned with their returns in US Dollars. If there are $N+1$ countries under consideration, then N currency risk premia must be considered.

Notationally, the expected return on an asset i can be expressed as follows:

$$E(r_i) = r_f + b_i\left[E(r_w) - r_f\right] + \sum_{n=1}^{N} \gamma_{i,n} E(r_n) \tag{2.20}$$

Where $E(r_i)$ is the expected return on asset i

$E(r_w)$ is the expected return on the world market portfolio

$E(r_n)$ is the expected return on the foreign currency of country n relative to the US Dollar

r_f is the US risk-free rate of return

b_i is the sensitivity of the expected return on asset i to the expected excess return on the world market (also defined in equation 2.17)

$\gamma_{i,n}$ is the sensitivity of the expected return on asset i to the expected return on the foreign currency of country n

The ICAPM like its domestic equivalent is subject to the same inherent weakness in its reliance on an unobservable hypothetical market portfolio. Finding a suitable proxy is even more formidable for the international model since the proxy should try to encapsulate the entire universe of internationally tradable assets. Whilst no such index exists, a market-value-weighted equity index comprising the equity market indices of the 48 countries under consideration in this study, should provide a sufficient proxy.

2.3.4.2. Empirical Tests using an Empirical ICAPM

Like the CAPM, the ICAPM is an equilibrium model of *ex ante* expected returns, which, by nature, are not directly observable. As a result the model must be tested through an empirical ICAPM, which employs *ex post* realised returns. As for the Single-Index model in section 2.3.2.2, it is assumed that there exists a suitable index to proxy for the market portfolio and that returns are stationary over time, and therefore that an empirical ICAPM can be employed to test the return generating process underlying the theoretical ICAPM.

Notationally, the empirical ICAPM required to test the ICAPM can be expressed as:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + \sum_{n=1}^{N} \gamma_{i,n} r_{n,t} + \varepsilon_{i,t} \qquad (2.21)$$

Where $r_{i,t}$ is the observed realised return on asset i at time t

$r_{m,t}$ is the observed realised return on the world market index at time t

$r_{n,t}$ is the observed realised return on the currency of country n relative to the US Dollar at time t

$r_{f,t}$ is the US risk-free rate of return at time t

α_i is the excess systematic return on asset i, unaccounted for by the risk premia

β_i is the sensitivity of the excess return on asset i to the excess return on the world market

$\gamma_{i,n}$ is the sensitivity of the excess return on asset i to the return on the foreign currency of country n

$\varepsilon_{i,t}$ is the unexplained residual return on asset i at time t

The error terms $\varepsilon_{i,t}$ are assumed to be independently, identically and normally distributed. The alpha term has an expected value of zero under the ICAPM, since the model is supposed to account for all systematic risk. Under the empirical ICAPM, the observed value of α_i should average out to zero over the sample of historical observed returns.

2.3.5 The Arbitrage Pricing Theory (APT) Model

Ross (1976) developed the APT model as an alternative approach to pricing assets, by integrating a multifactor return-generating process with arbitrage principles (i.e. the ability to generate a riskless profit with no initial investment).

2.3.5.1. Derivation of the APT Model

The APT model is simpler and more general than the CAPM, requiring fewer and simpler assumptions:

- Capital markets are frictionless and perfectly competitive.
- Investors prefer higher returns to lower returns.
- Investors are risk-averse.
- Investors have homogenous expectations regarding all parameters.
- Cash proceeds are received when an asset is sold short.
- The stochastic process generating asset returns can be simplified in the form of a linear set of factors.

Two points of interest are that the CAPM can be derived as a special case of the APT model with only one factor (the market portfolio) and that no assumption is made to say that investors are rational mean-variance optimisers.

The APT model of returns for an asset i is simply a linear combination of the expected return on the asset, the effect of unexpected risk factors and an unexplained residual return, notationally:

$$r_{i,t} = E(r_{i,t}) + \sum_{k=1}^{K} b_{i,k} f_{k,t} + \varepsilon_{i,t} \qquad (2.22)$$

Where $r_{i,t}$ is the realised return on asset i at time t

$E(r_{i,t})$ is the expected return on asset i at time t

$f_{k,t}$ is the k^{th} risk factor that impacts on asset i at time t

$b_{i,k}$ is the sensitivity of the return on asset i to factor k

$\varepsilon_{i,t,}$ is the unexplained residual return on asset i at time t

Systematic risk is represented by the assets' sensitivity to, and the variation of the common factors $f_{k,t}$. As a result, the APT model assumes that the return on a zero-investment portfolio with zero systematic risk, is zero in equilibrium. This follows from the diversification away of the firm-specific effects $\varepsilon_{i,t}$. The assumption of full diversification allows for the development of the market equilibrium expected returns model:

$$E(r_p) = \lambda_0 + \sum_{k=1}^{K} b_{p,k} \lambda_k \qquad (2.23)$$

Where λ_0 is the expected return on a portfolio p with zero sensitivity to all factors i.e. the risk-free rate of return

λ_k is the risk premium associated with any of the common factors f

$b_{p,k}$ is the sensitivity of the return on portfolio p to factor k

The fact that the APT model is very broadly defined is both its strength and weakness: it allows for equilibrium to be described in terms of any multi-index model but gives no indication as to what might be an appropriate multi-index model or appropriate values for the risk premia λ_k. Consequently, any number of common factors may be included in the model and they may be chosen by several different methods.

In choosing the number of factors to include, there is always a trade off between including more factors so as to explain more of the common variation and including fewer factors so as to make the model more parsimonious. Chen, Roll and Ross (1986) in their pioneering work on choosing economic factors, suggest that the model should include any systematic influences that impact future dividends, the rate at which investors discount future cash flows and the way market participants form expectations.

The factors may be chosen via statistical methods such as factor analysis or via a pre-specified structural approach whereby certain underlying economic relationships are assumed to exist *a priori*.

Statistical methods have the advantage that they do not put prejudgements into the model, but as McElroy and Burmeister (1998) point out, have the disadvantage that unknown random factors arise that have no straight-forward economic interpretation. Van Rensburg and Slaney (1997) address the interpretability issue by including equity market sub-indices in a Varimax rotation so as to derive a set of sub-indices with high loadings on the factors, which then proxy for those factors. Their proxy technique thus allows for derivation of statistical factors, which are both observable and economically interpretable.

Structural methods rely on economic factors (or economic proxies for factors), which are assumed to influence share returns. The advantage of a structural method is that the factors are economically interpretable: Chen, Roll and Ross (1986) pre-specified maturity premium, expected inflation, unexpected inflation, industrial production growth and default premium in a five-factor APT model to successfully explain stock returns on the New York Stock Exchange (NYSE). A strong disadvantage, as mentioned by Robertson (2002), is that because there is no method for picking the economic factors, there will always be uncertainty as to whether or not the correct factors were picked and hence the empirical viability of the model.

2.3.5.2. Empirical Tests using a Multi-Index Model

Like the CAPM and ICAPM, the APT model is again an equilibrium asset-pricing model of *ex ante* expected returns. Since expected returns are not directly observable and hence testable, an *ex post* realised returns model is once again required. The Multi-Index model serves this purpose and is specified as:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \sum_{k=1}^{K} \beta_{i,k}(r_{k,t} - r_{f,t}) + \varepsilon_{i,t} \qquad (2.24)$$

Where $r_{i,t}$ is the observed realised return on asset i at time t

$r_{k,t}$ is the observed realised return on factor k at time t

$r_{f,t}$ is the risk-free rate of return at time t

α_i is the excess systematic return on asset i, unaccounted for by the K betas

$\beta_{i,k}$ is the sensitivity of the excess return on asset i to the excess return on the k^{th} factor

$\varepsilon_{i,t}$ is the unexplained residual return on asset i at time t

The error terms $\varepsilon_{i,t}$ are assumed to be independently, identically and normally distributed. The alpha term has an expected value of zero since the APT model is supposed to account for all systematic risk. Under the Multi-Index model, the observed value of α_i should average out to zero over the sample of historical observed returns.

The APT model is preferred to the CAPM because it allows for multiple risk sources and can incorporate an observable market index as opposed to an unobservable, theoretically constructed market portfolio. For this reason 'anomalies' tend not to exits under APT, simply because any anomalous factor can be used to extend the APT model i.e. be incorporated as another factor. The disadvantage of the APT is précised by Fama (1991, p.1598): "multifactor models are licenses to search the data for variables that, *ex post*, describe the cross-section of average returns [factor dredging]."

2.4. Summary and Conclusion

This chapter provides a theoretical overview of market efficiency and asset pricing so as to put into context the empirical tests of the later chapters. Market efficiency and asset pricing are inherently linked in that any test of an asset-pricing model is automatically a test of market efficiency. The joint hypothesis problem means that a failed test could imply a poor asset-pricing model and / or an inefficient market.

Market efficiency is decomposed into weak, semi-strong and strong levels via the use of Fama's (1970) 'fair game' model. Mean-variance analysis is discussed and the CAPM is developed on a set of assumptions consistent with a market of rational mean-variance optimisers. The CAPM suggests that all investors will hold a portfolio comprising the market portfolio and a risk-free asset, but in different quantities, depending on their level of risk aversion.

The standard domestic CAPM is extended to cater for an international setting through the derivation of the ICAPM. Like the CAPM, the ICAPM suggests that investors will hold the same portfolio of risky assets, which is the world market portfolio when the global economy is under consideration. As for the CAPM, ICAPM investors adjust their risk exposure by holding varying amounts of the local risk-free asset. However, ICAPM investors are also exposed to foreign currency risk which can be countered through partial or full hedging by borrowing in the foreign currency and investing at home.

The APT model is suggested as an alternative asset-pricing model to the CAPM and ICAPM because its less stringent assumptions allow a more general model, which does not require an unobservable market portfolio. The APT allows for the inclusion of a market index as well as other factors, which would be termed 'anomalous' under the CAPM framework.

The literature, supporting and contradicting the theory discussed above, is reviewed in the following chapter.

-3-

Literature Review

"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it."

-Johnson (1775)

3.1. Introduction

The literature on market efficiency, asset-pricing models and so-called anomalous factors, is extensive and all three have many authors supporting and rejecting them. This chapter attempts to provide a balanced review of the most eminent works in the literature and highlights the significant contributions made by the various authors.

Section 3.2 considers the conflicting arguments for and against market efficiency. Section 3.3 reviews the evidence for and against the CAPM and section 3.4 then reviews the various lines of reasoning, which attempt to explain deviation from the CAPM. Section 3.5 reviews the arguments for and against the ICAPM and section 3.6 then reviews global risk diversification. Section 3.7 considers the methods for choosing factors under the APT model. Section 3.8 discusses the most common style anomalies found in the literature. Section 3.9 looks at seasonality in style anomalies and section 3.10 summarises and concludes.

3.2. Market Efficiency

An efficient market adjusts to new price information quickly and without bias and at all times reflects the relevant available price-determining information in the market. In an efficient market it is not possible to earn excess returns because all price-determining information is already included in the price. Consequently, asset prices are expected to follow a random walk and adjust instantaneously to new information as it arrives.

Roll (1977) points out that when testing market efficiency, the joint hypothesis problem is encountered in that all tests of market efficiency are in fact tests of the underlying asset-pricing model as well. Therefore, when a negative result is achieved, it is not possible to tell whether it is because the market is inefficient or because the asset-pricing model is misspecified or both.

3.2.1 Arguments for Efficient Markets

Kendall (1953) studies the trends in economic time series in UK stock price data and US commodities data in the 1920s and 1930s and concludes that in the short-term, the large random fluctuations in price tend swamp any systematic effects that may exist. The result is a wandering series, commonly known as a random walk, which supports the Efficient Market Hypothesis (EMH).

Roberts (1959) conducts similar, but less extensive, tests to Kendall (1953) and finds supportive results: he examines the trends in US economic time series data for both individual stocks and indices and finds random fluctuation and a lack of predictability, supporting the EMH.

Ball and Brown (1968) move away from trend analysis and instead consider the effect of accounting information on the price of securities by examining balance sheets and income statements of US companies from 1946 to 1966. They discover that the income figure in the official financial reports captures over half the relevant information for the year, but that the interim reports in the media capture 85 to 90 percent of the information in the official statements, reducing their significance. The EMH is supported because the time lag implies that the market seeks more timely methods to price in the data, thereby reducing the impact of the financial statements.

Fama, Fisher, Jensen and Roll (1969) focus on the effect of the speed of adjustment to specific kinds of new information, thus moving away from the established norm of testing for independent successive price changes. They find that the high level of expected future dividends associated with a stock split is priced in at least by the end of the split month, but often immediately. Prices typically adjust to the extent of the expected increase in future income from dividends. As a result abnormal excess returns cannot be achieved without inside information of the stock split and the EMH is supported.

Fama (1970) splits the EMH into three levels: weak form, semi-strong form and strong form. At the weak form level, where prices are assumed to reflect all previous price data, Fama (1970) finds strong support from the literature. When considering the semi-strong form, where prices are assumed to reflect all relevant publicly available information, Fama (1970) draws on less literature but still finds some support for the hypothesis. The strong form is not extensively tested and whereas the results tend to point towards some kind of strong form efficiency, no conclusive results are found. Instead, the strong form is retained as an ideal efficiency benchmark against which deviations from market efficiency can be assessed.

Fama and MacBeth (1973) consider common stock data on the New York Stock Exchange (NYSE) from the 1930s to the 1960s and find that the EMH is well supported: "we cannot reject the hypothesis that average returns on New York Stock Exchange common stocks reflect the attempts of risk averse investors to hold efficient portfolios" (Fama and MacBeth, 1973, p.633).

Treynor (1981) considers the costs of transacting in the market and researching securities and compares these with the profit opportunities that can be derived from such research. Treynor (1981) argues that the majority of traders on both sides of any market transaction are typically well informed and have informational or value driven motives for trading, thus supporting the semi-strong form of the EMH.

Seyhun (1986) considers US insider trading data from 1975 to 1981 and finds that inside information is valuable and that insiders are able to predict abnormal changes in price and profit from these changes. Moreover, they are able to discern between more and less valuable information and trade greater volumes to take advantage of the former. Seyhun's (1986) findings reject the notion of strong form market efficiency but support the semi-strong form of market efficiency as it is also shown that outsiders cannot use publicly available information about insiders' transactions to earn abnormal profits.

Fama (1991) reclassifies and extends his 1970 weak, semi-strong and strong form levels of efficiency to 'tests for return predictability', 'event studies' and 'tests for insider information'. Tests for insider information are inconclusive but in the event studies share prices are found to react quickly and without bias, supporting market efficiency at the semi-strong level.

Lakonishok and Lee (2001) examine an extensive data set of insider trades and discover that the benefits from insider trading are negligible because of two caveats: most of the market capitalisation is in large stocks where insider information has little value and trading in small stocks is costly, eroding any gain that could be made from the inside information.

3.2.2 Arguments against Efficient Markets

Jaffe (1974) reviews the literature regarding the ability to generate abnormal profits from insider information and finds mixed results. Jaffe (1974) examines 1960s data and concludes that insiders do possess relevant price-determining information. He finds that despite high transaction costs, insiders are still able to generate returns in the order of 2.5 percent over an eight-month holding period. This finding refutes Fama's (1970) hypothesis of strong form efficiency.

Jensen (1978) puts forth the first significant contention to the EMH summarising the slowly growing literature regarding anomalous stock market inefficiencies. He covers the work of Ball (1978) who finds systematically non-zero post-announcement risk-adjusted returns in twenty previous studies. Jensen (1978) also reviews the options work of Galai (1978) finding that options on the Chicago Board Options Exchange (CBOE) and their underlying stocks on the NYSE do not behave as a strictly synchronous single market. In Long's (1978) work, he finds that higher net returns are attainable on non-dividend paying utilities shares despite the positive tax implications of holding un-taxable cash dividend paying shares. Charest's (1978) study is also reviewed and shows that the prices of dividend paying stocks on the NYSE consistently under react to announcements of decreasing dividends.

Grossman and Stiglitz (1980) argue against market efficiency claiming that perfect information symmetry is only possible in a market where information is costless to attain. Grossman and Stiglitz (1980) argue that in reality information is costly and hence derive the Grossman and Stiglitz paradox: costly information means that prices do not reflect all the relevant available information, since if it did, those who spent the resources to attain the information would not be compensated for it.

Banz (1981) studies the risk-adjusted returns of NYSE common stocks and finds that smaller firms tend to outperform larger firms on a risk-adjusted basis. Reinganum (1981) and Basu (1983) find similar results when considering size and earnings-to-price as factors, whilst Keim (1983) documents both size and the January effect as significant factors. These anomalous factors point to either an inefficient market or a misspecified asset-pricing model or both.

De Bondt and Thaler (1985) examine contrarian investing in stocks on the NYSE for the period from 1926 to 1982. 'Loser' portfolios i.e. portfolios of stocks which previously performed poorly, tend to outperform 'winner' portfolios i.e. portfolios of stocks which previously performed well, typically earning 25 percent more over a 36 month period. In addition, 'losers' tend to exhibit a January effect, earning abnormal excess returns in the first month of every year.

French and Roll (1986) look at the variability of stock prices during trading hours versus their variability during non-trading hours. They find that prices are significantly more volatile during trading hours and conclude that the observed volatility is caused by private information, which affects prices when informed investors trade.

Fama and French (1988a) move away from shorter term tests and find a slowly mean-reverting component in stock prices, which tends to induce negative autocorrelation in returns. Fama (1991) finds similar results when assessing return predictability and consequently, weak form efficiency is not supported in the long run.

Lo and MacKinlay (1988) find serial correlation in weekly returns data from 1962 to 1985 on the NYSE/American Stock Exchange (AMEX). As a result, they dismiss both the random walk and stationary mean-reverting models of security prices. Jegadeesh (1990) conducts similar tests on monthly NYSE data over the period from 1934 to 1987 and finds strong negative first-order serial correlation and positive serial correlation at longer lags. Jegadeesh (1990) finds that there is a 2.49 percent differential per month between extreme decile portfolios.

De Long, Shleifer, Summers and Waldmann (1990) refute the EMH by studying the effect of so called 'noise traders' on share prices and returns. They find that noise traders, through their seemingly irrational behaviour, create risk in share prices, which deters rational investors and can result in large divergences of the share prices from their fundamental values. Noise traders then bear disproportionate amounts of risk and earn higher expected returns than rational investors.

3.3. The Capital Asset Pricing model (CAPM): Empirical Evidence

Development of the CAPM is attributed to Sharpe (1964), Lintner (1965), Mossin (1966) and Black (1972) who extend Markowitz's (1952) work on portfolio diversification for rational mean-variance optimisers. The CAPM relies on a theoretical market portfolio, which all investors are assumed to hold, but in different proportions to the risk-free asset, depending on their level of risk aversion. The CAPM dictates that because investors should hold diversified portfolios, firm-specific risk should be diversified away and hence investors are only rewarded for bearing systematic risk. The model uses beta to measure the relative riskiness of an asset compared to the market portfolio.

The joint hypothesis problem is again pertinent to this section in that tests of any asset-pricing model, such as the CAPM, are in essence joint tests of market efficiency and the accuracy of the asset-pricing model. Consequently, failed tests can imply an inefficient market, a misspecified model or both.

3.3.1 Arguments for the CAPM

Black (1972) empirically tests the CAPM under two scenarios: in the presence of a risk-free asset and in the absence of a risk-free asset. In both cases, the expected return is found to be a linear function of beta.

Black, Fisher, Jensen and Scholes (1972) find a positive beta relationship in their study of US data from 1926 to 1966. However, they also find that low beta shares seem to produce greater returns than those predicted by the CAPM and that high beta shares seem to produce lower returns than those predicted i.e. zero-beta portfolios return greater than the risk-free rate of return and the slope of the CML is less than one.

Blume and Friend (1973) find support for the CAPM in their study of NYSE common stocks, finding linear relationships between risk and expected return. However, they find that the CAPM is unable to explain the risk-return relationship for all assets in general and suggest some kind of segmentation as a possible explanation, especially in bond markets.

Fama and MacBeth (1973) test the 'two-parameter' model i.e. the CAPM risk and return model, on NYSE common stocks over a period from the 1930s to the 1960s. They are unable to reject the hypothesis that risk-averse investors attempt to hold portfolios that are efficient in terms of the risk and return.

3.3.2 Arguments against the CAPM

Bhandari (1988) provides evidence to suggest that beta does not sufficiently describe the equilibrium risk-return relationship. He shows that after controlling for firm size and beta, the debt-to-equity ratio is still able to explain excess returns, regardless of the choice of market proxy. The implication of the significant results with varying proxies is that the CAPM is misspecified and that beta does not fully capture the risk-return relationship.

Fama and French (1992) use NYSE common stock data from 1962 to 1989 to accurately describe the cross-sectional variation in stock returns in terms of size and book-to-market value. Moreover, it is found that when stock returns are controlled for size, and beta is allowed to vary, the relationship between average return and market beta is flat, even when beta is the only explanatory variable. The CAPM is thus strongly rejected as an accurate asset-pricing model.

Jegadeesh (1992) argues that the successful results of earlier tests of beta are spurious because the tests were conducted on size-based portfolios, where the cross-sectional correlation between firm-size and beta was close to one. Jegadeesh (1992) shows that when portfolios are constructed so that beta and firm-size have low correlation, beta explains virtually none of the cross-sectional variation in returns.

Fama and French (1993) use NYSE, AMEX and NASDAQ share data and corporate and government bond data from 1963 to 1991 and find that three factors explain the cross-sectional variation in share returns: a market factor, a size factor and a market-to-book value factor. Size and market-to-book value are suggested as proxies for an unidentified systematic risk factor.

Daniel and Titman (1997) find that both size and market-to-book ratios are highly correlated with average stock returns, when considering NYSE common stock from 1963 to 1993. They argue that the anomalous factors have explanatory power in themselves and are not simply proxies for systematic risk factors as hypothesised by Fama and French (1993). The implication is thus that the covariance structure of returns has less value than easily observable firm-specific characteristics, and therefore that the CAPM is not suitable as an asset-pricing model.

3.4. Explanations for Deviations from the CAPM

MacKinlay (1995) argues that the explanations for any deviation from the CAPM are best categorised as either risk-based or non risk-based. The risk-based explanations posit that the failure of the CAPM is the result of some missing risk factor in the model. Hence, by extending the CAPM to a multifactor model, for example the APT model, many authors have tried to explain the risk that was previously unaccounted for. The non risk-based explanations rely on some kind of bias, in the testing, in the data or in the mentality of market participants.

3.4.1 Risk-Based Explanations

3.4.1.1. Multifactor Asset-Pricing Models and Misestimated Risk

Klein and Bawa (1977) find that if insufficient information is available about a certain subset of securities, then investors will not hold any securities in this subset because of estimation risk. Essentially, investors cannot assess the true parameters of the return distribution for this subset and hence would rather limit their diversification to different subsets of securities. Banz (1981) supports Klein and Bawa's (1977) model and suggests that the size effect is directly applicable to their model: small firms have less information available and hence receive less investment and earn higher returns. Arbel and Strebel (1982; 1983) argue that the size effect is caused by large institutional traders who neglect small firms and therefore perpetuate a consistent lack of information relating to these firms. Reinganum and Smith (1983) further the argument of Banz (1981) by suggesting that insider information is more beneficial when trading in small firms, since the information differential between insider and outsider is generally greater. Consequently, outsiders tend to avoid smaller firms and would rather invest in larger firms where the information differential is lower. Barry and Brown (1984) use 'period of listing' as a proxy for the quantity of information available and find a relationship between period of listing and share return that cannot be explained by the size or January effects. However, they reason that period of listing is an insufficient proxy for the quantity of information available and that a better measure of information is required in order to fully explain the anomalous size effect. Arbel (1985) suggests the coefficient of variation in analysts' forecasts and finds a strong correlation with share returns. Consequently, Arbel (1985) concludes that because less information is available for smaller firms and because there is a significant relationship between information and expected return, smaller firms must provide greater expected returns.

Roll (1977) suggests that the two-parameter model of Black (1972) is not testable unless the exact composition of the true market portfolio is known and used in the tests. He further concludes that the use of a proxy can result in several difficulties: the proxy may be efficient and the true market portfolio inefficient or the proxy may be inefficient whilst the true market portfolio is efficient. Fama and French (1996a) support the later part of Roll's (1977) finding, concluding that the CAPM cannot be conclusively tested until the true market portfolio is known, because any empirical failure could simply be the result of a poor market proxy.

Ball (1978) finds that anomalous earnings factors are able to explain the variation in excess returns. He concludes that the earnings variables either proxy for some omitted factors or some other misspecification effects in the two-parameter mean-variance model. Reinganum (1981) finds a significant size effect and rejects the CAPM because of model misspecification, on the basis of prolonged abnormal returns. Jegadeesh (1990) finds a significant size effect that persists after controlling for beta and is independent of the estimation technique used to find beta. Fama and French (1992; 1993) agree with the hypothesis that the anomalous variables proxy for some unobserved risk factor, which is able to explain the cross-section of returns beyond the ability of the CAPM. The Fama and French (1993) three-factor model, which includes market, size and market-to-book value factors, successfully explains the variation in the cross-section of returns. Similarly, Grinblatt and Titman (1988; 1989) successfully develop and test an eight-factor model which includes four size-based portfolios, three portfolios based on dividend yield and one momentum style portfolio.

Daniel and Titman (1997) find size and book-to-market effects but unlike Fama and French (1993), they find that it is the co-movement of the share prices with factors that results in the observed effects rather than the covariance structure of returns. As a result, Daniel and Titman (1997) purport that it is the characteristics of the individual factors that produce the effects.

3.4.2 Non Risk-Based Explanations

3.4.2.1. Statistical and Methodological Biases

Data snooping (or data mining) is a methodological bias that can arise in empirical studies because of data sorting on the basis of data-instigated characteristics. Lo and MacKinlay (1990) use Monte Carlo simulations to show that if the same data set is repeatedly used to draw inferences, then the probability of finding significant but spurious results increases. Furthermore, if asset-pricing models are constructed on the basis of the supposed significant factors, then the results of the model will be inherently biased in favour of the factors. Lo and MacKinlay (1990) suggest that the size effect may be a direct result of such data snooping. Black (1993) criticizes the work of Fama and French (1992) on the basis that their significant size and book-to-market effects had previously been shown to be significant in the literature, and hence were subject to data-snooping bias.

Survivorship bias is a statistical bias that can arise in returns data when poorly-performing firms go out of business. The better performing shares remain in the sample and hence positively bias the data. Davis (1994) uses a sample free of survivorship bias and finds significant book-to-market value, earnings yield and cash flow yield effects. More significantly, he finds a significant January seasonal in all the effects, despite the fact that small firms were exclude from the sample by construction. Kothari, Shanken and Sloan (1995) argue that the relationship between book-to-market value and returns is weaker and less consistent than proposed by Fama and French (1992). Kothari, Shanken and Sloan (1995) argue that survivorship bias significantly amplifies the observed effects, whilst Chan, Jegadeesh and Lakonishok (1995) find that the effects of survivorship bias are exaggerated: at most only 3.1% of the company-years in the NYSE-Amex sample are omitted because of financial distress. Fama and French's (1996a) rebuttal to Kothari, Shanken and Sloan (1995) provides evidence to show that the book-to-market value effect is still significant even in the absence of survivorship bias. Van Rensburg (2001) agrees with Chan, Jegadeesh and Lakonishok (1995) and Fama and French (1996a), arguing that survivorship bias is unlikely to be a major distorting influence in studies that employ large non-thinly traded firms in their samples.

Look-ahead bias is a methodological bias arising from the use of predictor variables, which are actually unknown to market participants at the time when they are recorded in the data set. Banz and Breen (1986) construct a data set which is free of look-ahead bias by lagging the predictor variables with respect to the returns data. Their study shows that the price-earnings effect disappears when the statistical bias is removed from the sample.

Litzenberger and Ramaswamy (1979) comment on the loss of information that arises because of the construction of attribute-sorted portfolios, the likes of which are frequently used in the literature to identify factors and develop asset-pricing models. Michaud (1999) agrees and cites the work of Ferson (1998) who shows that spread or long-short portfolios will appear to imply the existence of risk factors in attribute-sorted portfolios, even when the attributes are completely unrelated to risk.

Roll and Ross (1994) look at the statistical sensitivity of the cross-sectional ordinary least squares (OLS) regression relationship between share returns and the type of index used. They find that the relationship is very sensitive to the index chosen and that indices can be close to each other, and to the mean-variance efficient frontier, and still produce significantly different cross-sectional slopes. Chan and Chen (1988) suggest that the large measurement errors inherent in beta estimation allow firm size to proxy for the true market beta. They find that when more accurate measurement techniques are employed, the size effect in fact disappears.

Becker and Ochman (2004) suggest that inter-country biases can arise because of differences in capital structure, accounting systems, reporting policies, and other factors contributing to the non-homogeneity of the investment universe.

3.4.2.2. Market Frictions

The CAPM is based on numerous assumptions, one of them being the assumption that the market is perfectly frictionless and therefore that investors are not subject to transaction costs and taxes. The reality is that transaction costs and taxes are often considerable and that some shares are far from liquid, resulting in significant deviations from the CAPM.

Banz (1981) and Reinganum (1981) find significant size effects, whereby small firms outperform larger firms in the absence of transaction costs. Stoll and Whaley (1983) incorporate transaction costs into their size effect tests and find a reversal in the effect i.e. large firms tend to outperform small firms. For a holding period of one month, small firms produce significant negative returns net of transaction costs, and for holding periods between three months and one year, the returns are not significantly different from zero.

Brennan (1970) constructs a CAPM-style market model, which incorporates two exogenously determined marginal tax rates: a capital gains tax rate and a slightly larger income tax rate. Brennan (1970, p.423) finds that the higher the income tax level and the higher the dividend yield, the greater the cost of tax on dividends and therefore the greater the required rate of return on the share.

Singer (1979) uses endogenously determined marginal tax rates and shows that the traditional CAPM will only hold if the before-tax distribution of wealth is normal. If this is not the case, then investors hold an after-tax mean-variance efficient portfolio, which is inefficient before tax.

Constantinides (1983) focuses on market equilibrium in the presence of capital gains tax and finds that the expected rate of return is a function of its variance and the frequency with which forced security sales are made.

Lai (1989) incorporates progressive personal taxes in an equilibrium model and finds that the traditional CAPM understates the expected excess rate of return and exhibits a misspecification error.

Amihud and Mendelson (1986) investigate the relationship between share returns and the bid-ask spread and find that liquidity affects returns because the shares of small firms are generally less liquid and hence require a premium in the form of higher returns.

3.4.2.3. Investor Irrationality

Investor irrationality manifests itself in the overreaction hypothesis, which posits that investors typically overreact to unexpected news, resulting in large movements in share prices, which are subsequently followed by rectification. The CAPM assumption of investor rationality is violated and the induced excess volatility leads to deviations from the CAPM.

Basu (1977) considers the price-earnings effect and finds that investors tend to overreact to unfavourable earnings announcements, depressing the P/E ratio until earnings exceed the overly pessimistic forecasts, at which time the price corrects. Similarly, investors become overly enthusiastic about favourable earnings announcements until the share is clearly overvalued and earnings are less favourable than expected, at which time the price corrects.

De Bondt and Thaler (1985) find that prior 'winners' i.e. stocks that performed well in the previous period tend to be outperformed by prior 'losers' i.e. stocks that performed poorly in the previous period. The out-performance of the losers tends to last for up to 36 months and thus clearly supports the overreaction hypothesis and the subsequent correction. De Bondt and Thaler (1987) further show that firm size is independent of the overreaction hypothesis. Chan's (1988) results are less conclusive and he argues that the estimation of the abnormal return to the contrarian investment strategy of 'winners' and 'losers' is sensitive to both the model and estimation techniques employed.

Lakonishok, Shleifer and Vishny (1994) study 'glamour' stock i.e. stocks that are in-favour and have high P/E multiples, and 'value' stock i.e. stocks that are out-of-favour and have low P/E multiples, investing. They find that institutional investors tend to invest in glamour stocks for two main reasons: firstly, glamour stocks have not been in any kind of financial distress recently and as such are easier to justify to clients. Secondly, value stock investment is inherently long term as share prices need time to correct to their true value, and as a result, value investments can under-perform for extended periods of time. Investment managers cannot afford to under-perform the index or their competitors for any period of time or else their clients will withdraw their funds. The result is that institutional investors tend to follow irrational glamour stock investment strategies, which are shown to return less and fundamentally be just as risky as value strategies.

3.5. The International CAPM (ICAPM): Empirical Evidence

Relatively few tests of the ICAPM have been performed thus far in the literature, primarily because of the lack of historical data available on international capital markets (see Solnik, 2000, p.170). In addition, like the domestic CAPM, there are the added difficulties of identifying the market portfolio, non-stationary expected returns and time-varying beta risk measures.

The joint hypothesis problem is again evident in that any test of the ICAPM is also a test of the efficiency of the underlying world market. International market efficiency is reflected in fully integrated markets, which are characterised by free capital flows across borders and consistent asset pricing of similar assets is different countries.

The literature can be examined in terms of arguments for and against the ICAPM, with arguments for the model being separated into tests via the pricing of currency risk, via the segmentation of risk factors into international and country-specific factors and via other firm-specific attributes. Arguments against the model tend to focus on finding a home investing bias in the data.

3.5.1 Arguments for the ICAPM

3.5.1.1. Via the Pricing of Currency Risk

Solnik (2000, p.171) divides tests of the ICAPM via the pricing of currency risk into unconditional and conditional tests. Unconditional tests assume that all expected returns and risk measures are constant over time. Clearly, this is an impractical assumption and thus, in line with Solnik, these tests will not be reviewed. Conditional tests allow for some kind of time variation in both the expected returns and risk measures over time.

Dumas and Solnik (1995) model the time variation in expected returns and risk and reject a model that excludes currency risk factors (the gamma values in equation 2.20).

De Santis and Gérard (1998) use a GARCH methodology to model the variation and find strong support for an ICAPM model which includes market risk and currency risk premia.

3.5.1.2. Via Segmentation of Risk Factors into International and Country-Specific

Segmentation tests are based on mixed models, which include both international and country-specific factors. If the country-specific factors can be shown to be insignificant, then this lends support to the ICAPM since all risk can then be attributed to international risk (captured by the beta and gamma values in equation 2.20).

Bekaert and Harvey (1995) model expected returns in terms of the world market portfolio and the variance in country returns. Intuitively, in a more integrated market an asset should be priced in terms of its sensitivity to the world market portfolio, whilst in a segmented market an asset should be priced in terms of its own country's risk. Bekaert and Harvey (1995) study emerging markets and, by allowing the degree of segmentation to change over time, find that most emerging markets, whilst starting off segmented, have become increasingly more integrated over time.

De Santis and Gérard (1997) study developed markets and like Bekaert and Harvey (1995) model expected returns in terms of the world market portfolio and the variance in country returns, but unlike the previous authors, they also include a constant term to take account of other forms of segmentation. Solnik (2000, p.169) cites legal constraints, fear of expropriation, discriminatory taxes, psychological aspects and higher investment costs as possible forms. De Santis and Gérard (1997, p.1901) find that expected excess returns are positively related to their conditional covariance with a worldwide portfolio and that country-specific risk is not priced.

3.5.1.3. Via Other Firm-Specific Attributes

Fama and French (1998) perform an international study in which they consider thirteen major markets and find that in twelve out of the thirteen cases 'value' stocks outperform 'growth' stocks. The 'value' and 'growth' definitions are based on value ratios and other attributes such as those examined in this study (see table 4.1). They argue in terms of financial distress and suggest that another term should be added to the ICAPM to capture this risk. Whilst this finding appears to oppose the ICAPM, Ferson and Harvey (1998) find that the price-to-book-value ratio is highly correlated with the share's world stock market risk exposure, and thus that an additional term may not be required.

3.5.2 Arguments against the ICAPM

French and Poterba (1991), Cooper and Kaplanis (1994) and Tesar and Werner (1995) all consider whether or not investors have a preference between investing at home and investing abroad. They find that there is a significant home preference, which cannot be adequately explained. Whilst their findings do not suggest complete market segmentation, they do suggest that full integration has not yet been achieved and therefore that the ICAPM cannot hold perfectly. It should be noted that the opposing literature, whilst casting some doubt on the ICAPM, does not preclude the ability of the model to produce "useful and robust implications regarding the pricing of securities" (Solnik, 2000).

3.6. Global Risk Diversification

3.6.1 Arguments for Global Risk Diversification

Grubel (1968) applies the Markowitz (1952) model of portfolio diversification to an international setting. Grubel (1968, p.1307) finds that by constructing a diversified portfolio comprising assets from eleven industrialised countries, it is possible to increase annual returns by 68%, whilst still being exposed to the same level of risk. Levy and Sarnat (1970) extend the work of Grubel (1968), considering 28 countries in their analysis. They construct numerous portfolios and confirm the benefits of diversification into uncorrelated economies. They point out that investing purely in developed or emerging countries is suboptimal and that it is the low correlation between the developed and emerging economies that produces the benefits of diversification. Errunza (1977) conducts a similar analysis on 29 countries of developed and emerging status and finds similar benefits to diversifying into emerging markets. Cosset and Suret (1995) use both *ex post* and *ex ante* methods to test the impact on the risk-return relationship of diversifying into politically risky countries. They find that such diversification not only improves the risk-return characteristics of optimal portfolios but also leads to an overall reduction of portfolio risk. De Santis and Gérard (1997) find that the expected gains to a US investor from international diversification average 2.11% per year and that the gains have not significantly declined over time.

Solnik (1974, p.49) considers seven European countries and the US and finds that investing abroad is relatively more attractive for Europeans because a large proportion of the largest European firms are privately owned. Solnik (1974, p.52) also considers exchange risk and discovers that whilst uncovered international portfolios are more risky than covered international portfolios, they are considerably less risky than portfolios constructed from purely domestic assets.

Biger (1979) considers the impact of the home country on the choice of international portfolio to be held. Biger (1979, p.68) finds that the portfolios held by investors in different countries should be very similar despite the effect of domestic currency devaluation and the resultant higher correlation between foreign market indices. Solnik (1983) constructs an international arbitrage pricing theory model, the results of which strongly support those put forward by Biger (1979): "if a factor model is believed to hold when asset returns are expressed in some arbitrarily chosen currency, this factor structure, as well as its major conclusions, is invariant to the currency chosen" (Solnik, 1983, p.454).

Stulz's (1984) study focuses on the application of capital asset pricing models in an international setting. His results contrast those of Biger (1979) and Solnik (1983) in that they suggest that an investor's home country affects the choice of international portfolio held because of differing inflation rates, consumption baskets and opportunity sets.

Jorion (1985) moves away from empirical testing of *ex post* realised returns, as previously employed in the literature, and instead uses an *ex ante* method for estimating expected returns. His results indicate that *ex post* methods tend to overestimate the possible gains in terms of average returns and that in fact benefits from international diversification are more likely to accrue from reduced risk.

3.6.2 Arguments against Global Risk Diversification

French and Poterba (1991) address home bias and find that despite the benefits of international diversification illustrated in the literature, investors *choose* to invest at home and that the bias is not the result of institutional constraints. Aizenman (1999, p.1006) suggests that home bias may be the result of un-diversifiable exchange rate risk in that if the equities of two countries are equally volatile and exchange rate risk cannot be diversified away, then foreign equity will be seen as inherently more volatile than the corresponding domestic equity.

Longin and Solnik (2001) propose a further caveat in the global diversification argument as they show that the correlation between international markets, whilst remaining constant in bull markets, increases during bear markets, thereby limiting the benefits of international diversification.

3.7. The Arbitrage Pricing Theory (APT) Model

3.7.1 Statistical Methods (Factor Analysis)

Roll and Ross (1980) are among the first to use a factor analytic approach to extract APT model factors. They consider US data from 1962 to 1972 and use a covariance matrix of stock returns to identify and successively extract factors up to the point when the next factor makes little contribution to the model's explanatory power. They suggest the extraction of four to five factors but accept that the maximum likelihood and generalised least squares methodologies used lack statistical power.

Shanken (1982, 1985) argues that the nature and number of extracted factors will always depend on the sample and that the factors derived by factor analysis are not unique. Dhrymes, Friend and Gultekin (1984), Trzcinka (1986), Brown (1989) and Fama (1991) all share the same concerns regarding the uncertainty surrounding the number of factors to be extracted. Essentially, they argue that because there is no restriction on the number of factors that can be extracted, factor dredging can easily occur with sample-specific factors. McElroy and Burmeister (1988) and Fama (1991) further criticize the approach for producing random factors which have a lack of economic interpretability.

3.7.2 Structural Methods (Economic Factors)

Chen, Roll and Ross (1986) choose a set of economic state variables, which were, *a priori,* candidates as sources of systematic risk. In the US for the period from 1953 to 1983, they find that several of the factors are significant in explaining expected stock returns, namely industrial production, changes in the risk premium and twists in the yield curve. Hamao (1988) constructs a similar model for the Japanese equity market for the period from 1975 to 1984 and finds that changes in expected inflation, unanticipated changes in the risk premium and unanticipated changes in the slope of term structure have a significant effect on the market.

Robertson's (2002) criticism (see section 2.3.5.1) of structural methods is reiterated: the empirical viability of a structural model must always be in question because there is no method for picking the economic factors and as such, there will always be doubt as to whether the correct factors were picked.

Van Rensburg and Slaney (1997) address the interpretability issue by first performing factor analysis and factor rotation on South African shares and sub-indices. They then find sub-indices which exhibit high loadings on the factors and use these sub-indices as proxies for the factors. The result of using such proxies is an economically interpretable model with factors, which are both observable and non-arbitrary.

3.8. Style Anomalies

Style anomalies are factors that are able to explain the variation in average excess returns after risk adjustment by an asset-pricing model. They are anomalous in the sense they account for unexplained variation that the asset-pricing model should account for. Many factors have been found, which successfully explain the cross section of excess returns, either in unison, or in combination with other factors. Given the vast literature available, only some of the more pertinent findings are reviewed and where factors seem to be intrinsically linked, they are reviewed together.

3.8.1 The Size, Earnings-to-Price and Book-to-Market Value Effects

Basu (1977) uses NYSE common stocks during the period from 1956 to 1971 to construct portfolios of low price-to-earnings (P/E) and high P/E stocks. He finds that the low P/E portfolios tend to have greater absolute and risk-adjusted returns than the high P/E portfolios.

Ball (1978) considers the NYSE and the Melbourne Stock Exchange and finds a similar earnings effect to Basu (1997). He argues that since publicly announced earnings are a public good, they require no private cost to attain and hence should not earn a private return. He posits that the earnings effect either proxies for omitted variables or misspecifications in the CAPM.

Banz (1981) studies NYSE common stocks from 1926 to 1975 and finds the existence of a size effect for over forty years. He finds that small firms tend to outperform average and large firms but that the effect is not linear in that average-sized firms do not significantly outperform large firms. Banz (1981) does not make any judgment towards whether the size effect is actually caused by size or by some unknown factor for which size proxies.

Reinganum (1981) uses NYSE and AMEX common stock data over a five-year period from 1970 to 1975 to construct portfolios based on size and earnings-to-price (E/P) ratios. The portfolios generate returns, which are systematically different to those predicted by the CAPM. It is also found that the E/P effect is not significant after controlling for size and therefore that the two anomalies have some intrinsic link and could be proxies for the same set of missing factors. Size is presented as the most significant pricing factor.

Basu (1983) collected data from the NYSE from 1963 to 1979 and arrives at similar size and E/P effects to Reinganum (1981). However, Basu (1983) controls for size and finds that the E/P effect is still significant. The intrinsic link between the two effects is not dispelled and it is proposed that perhaps the dynamic between size, E/P and expected returns is far more complex than previously documented.

Brown, Kleidon and Marsh (1983) examine the NYSE data of Reinganum (1981) and build on the work of Banz (1981) and Reinganum (1981), finding a linear relationship between the logarithm of size and expected return. However, they find that the relationship is not stable over time i.e. the estimates are sensitive to the time period under consideration.

Chan and Chen (1991) study NYSE and NASDAQ data from 1956 to 1985 and find a significant size effect. They argue that smaller firms require a greater expected return because they are inherently more risky: they are generally more highly levered and hence in greater risk of financial distress; they also tend to be doing worse financially, than the larger firms in their industry.

Fama and French (1992) examine the size and book-to-market value (B/MV) effects in NYSE, AMEX and NASDAQ data from 1962 to 1989. They find that size and B/MV combine to explain the cross-sectional variation in average stock returns associated with, not only size and B/MV, but also market beta, leverage and E/P. They show the redundancy of the latter three factors and argue that size and B/MV combine to proxy for some systematic risk factor.

Berk (1995) argues that the size effect is not an anomaly at all because it can be shown *theoretically* that in an economy where risk and firm size are completely unrelated, the logarithm of market value will be inversely related to expected return. The logic is that riskier firms will be required to provide greater returns and thus have lower prices. If market value is used as a measure of size, then in any cross-sectional analysis, market value and expected return will be negatively correlated by construction i.e. small firms (as measured by market value) will always generate greater returns irrespective of risk or asset-pricing model. Van Rensburg and Robertson (2003) suggest that Berk's (1995) logic can be extended to other financial ratios that use market values in their construction. To remedy the bias, van Rensburg and Robertson (2003) suggest lagging the financial ratios with respect to the share returns.

Dimson and Marsh (1999) consider both UK and US data from 1955 to 1997 and find a significant size effect, which reverses in the 1989 to 1997 period i.e. large capitalisation firms tend to out perform small capitalisation shares in the 1990s. Dimson and Marsh (1999) find that the reversal is as a result of a change in fundamentals such as technology, economies of scale and market power, and not simply because of investor sentiment. It is noteworthy that even though the effect has reversed, it is still significant.

Gustafson and Miller (1999) consider the NYSE over an extended period from 1926 to 1997 and find the same size effect reversal as Dimson and Marsh (1999). However, Gustafson and Miller (1999) reason that there is no fundamental reason for the reversal and hypothesize another reversal in the future.

Chan, Karceski and Lakonishok (2000) consider NYSE data from 1970 to 1999, finding a similar reversal in the size effect to both Dimson and Marsh (1999) and Gustafson and Miller (1999), in the latter years of the sample. A behavioural explanation for the reversal is provided, which runs along the lines of that reasoned by Dimson and Marsh (1999). Chan, Karceski and Lakonishok (2000) argue that electronic commerce dominated in the 1990s and because of the high research and development costs in the industry, the large firms benefited from economies of scale unattainable by smaller firms.

3.8.2 The 'January' Effect and Seasonality

3.8.2.1. The 'January' Effect

Rozeff and Kinney (1976) provide the first conclusive evidence of seasonality in stock returns in their study of NYSE common stock data from 1904 to 1974. They find that there are statistically significant differences in monthly returns, primarily because of large January returns.

Keim (1983) studies NYSE and AMEX data and finds that in the period from 1963 to 1979, there is a significant size effect (small firms outperforming large firms) and that up to fifty percent of this size effect is attributable to abnormally high returns in the month of January.

Cook and Rozeff (1984) consider NYSE common stocks from 1964 to 1981 and re-examine the conflicting results of Reinganum (1981) and Basu (1983). They find that Reinganum's (1981) conclusion that size subsumes E/P is caused by a fortuitous choice of methods and that Basu's (1983) precisely opposite conclusion is sample specific. Cook and Rozeff (1984) find three significant effects and two significant interactions. The size and E/P effects are both significant but do not interact and, in support of Keim (1983), roughly half of each effect occurs in the month of January.

Jaffe, Keim and Westerfield (1989) try to reconcile the differences found in the anomaly literature by using more rigorous tests and a larger sample period from 1951 to 1986. They find significant E/P and size effects but also find that only the E/P effect is significant when the month of January is controlled for. The size effect is thus found to be peculiar to January.

Bhardwaj and Brooks (1992) suggest that over the 1977-1986 period the January effect is not really peculiar to small market capitalization firms but rather to low-price shares. They purport that high transaction costs and large bid-ask spreads dominate any observed seasonality in returns and that in fact, the January effect is not persistent.

Loughran (1997) considers the 1963 to 1995 period on the NYSE and finds a strong January seasonal on value stocks and small returns on newly listed growth stocks outside the month of January. In combination, these two effects manifest themselves as the previously documented B/MV effect.

3.8.2.2. Other Seasonal Effects

Gultekin and Gultekin (1983) find strong seasonality in their study of 17 industrialised countries. With the exception of Australia, the months with disproportionately high payoffs coincide with the turn of the tax year. Most countries have a tax year beginning January and so experience a January seasonal but for the UK an April seasonal is observed, coinciding with the beginning of the UK tax year. Agrawal and Tandon (1994) find seasonality in 14 of the 18 countries they study. Whereas the tax-loss-selling hypothesis is supported in most cases including the US and UK, the effects in Canada, Denmark, Australia, New Zealand and Hong Kong cannot be explained by their tax-year ends.

Reinganum and Shapiro (1987) consider UK data and find both a January and April seasonal in the returns data. They suggest that whilst the April seasonal is consistent with the UK tax year and the capital gains tax-loss-selling hypothesis, the January seasonal cannot be explained. Clare, Psaradakis and Thomas (1995) identify January, April and December rises and September falls in the UK stock market and the results appear to be robust across firm size. Priestly (1997) observes the same January, April and December effects and attributes the January and December effects to the increased risk of holding shares during this period, which is regarded as an important part of the business cycle and attributes the April effect to the tax-loss-selling hypothesis.

Corhay, Hawawini and Michel (1987) study British, French, Belgian and North American returns data and discover a January seasonal for France, Belgium and the US and, like Reinganum and Shapiro (1987), January and April seasonals in the UK.

Tinic, Barone-Adesi and West (1987) consider Canadian equities and find a strong January seasonal which cannot be explained solely by the tax-loss-selling hypothesis.

Bouman and Jacobsen (2002) identify another type of seasonality, which they refer to as the 'sell in May and go away' effect. They find that in 37 of the 38 countries studied, the effect is supported and that returns are significantly lower from May to October than they are for the rest of the year. The effect is found to be particularly strong in European countries and no adequate explanation is given. Athanassakos (2005) studies Canadian equities and finds a similar 'sell in May and go away effect' and January seasonal to those discovered by Tinic, Barone-Adesi and West (1987).

3.8.3 The Debt-to-Equity Effect

Bhandari (1988) considers the period from 1948 to 1979 on the NYSE and finds that debt-to-equity (D/E) is positively related to the returns on common stocks, after controlling for beta, size and the January effect. The D/E effect is stronger in January but is insensitive to estimation technique and market proxy. Consequently, Bhandari (1988) concludes that D/E does not proxy for beta with respect to the market proxy but could possibly proxy for beta in relation to the true market portfolio.

3.8.4 The Dividend Yield Effect

Litzenberger and Ramaswamy (1979) consider the effect of tax and the dividend yield on NYSE data from 1936 to 1977. They find that there is a strong positive relationship between the dividend yield and the before tax expected return on common stocks and that the effect is stronger in the ex-dividend month than in any other month. Litzenberger and Ramaswamy (1979) are supported by Blume (1980), who finds a similar dividend yield effect in the period from 1946 to 1976.

Keim (1985) considers NYSE common stock data from 1931 to 1978 and examines the dividend yield effect, finding a nonlinear relationship between long-run dividend yields and returns in January. Even after applying an after tax model, which accounts for the differential treatment of dividends and capital gains, and adjusting for the size effect, Keim (1985) still finds a significant January seasonal. The findings imply that there is some other factor related to dividends that influences share returns even after accounting for the differential tax treatment of dividends and capital gains.

Fama and French (1988b) test the 1927 to 1986 period on the NYSE for a dividend yield effect and find that in the short run (monthly or quarterly), the dividend yield typically explains less than five percent of the variation in share returns. However, in the long run (two to four years), they find that the dividend yield is far more significant, explaining in excess of 25 percent of the variation.

3.8.5 Other Anomalous Factors

Ou and Penman (1989) use a summary measure, which they extract from financial statement information, to successfully predict the direction of one-year earnings changes. They examine the period from 1973 to 1983 on the NYSE/AMEX and find that their summary measure is significant, even after controlling for the size effect.

Campbell, Grossman and Wang (1993) consider the relationship between trading volume and the serial correlation of daily stock returns. The NYSE/AMEX data from 1962 to 1987 shows that a price decline is more likely on days where the trading volume is high and thus that trading volume and expected return are significantly negatively related.

Jegadeesh and Titman (1993) use a momentum investor strategy of buying past winners and selling past losers in the 1965 to 1989 period in the US. They find that their zero-cost winner and loser portfolios (based on the previous six months returns) earn significant returns when held for six months after formation.

3.8.6 Multiple Factors

Michaud (1999) considers five markets, namely France, Germany, Japan, the United Kingdom and the United States over the period from 1990 to 1997. He investigates the seven style factors of asset yield, cyclicality, earnings trend, earnings yield, normalised earnings yield, return reversal and size. The significance of the factors seems to vary with the market, where typically two to four factors are significant in each market. Only earnings trend and return reversal are significant in all markets. Michaud's (1999) results imply that strict style-based investment is ineffectual on a global basis since significant style factors seem to vary between markets.

3.8.7 Style Consistency, Rotation and Timing

When using style based investment decisions, investors must also consider whether the style is expected to be constant over time or if it is expected to change direction and if so, when and how often the changes are expected. A review of the pertinent style timing literature follows.

Kahn (1996) examines a variety of American mutual funds and finds that they tend to have inconsistent styles, investing in value stocks for a period and then growth stocks for a period. Some are also found to hold combinations of value and growth stocks in the same period. As well as being inconsistent in terms of style, mutual funds are found to be inconsistent in terms of size, with portfolios of small and large capitalisation stocks being held at different times.

Macedo (1995) studies eighteen countries over the period from 1975 to 1993 and finds that volatility is a useful indicator of country selection style. She suggests that relative value and relative strength are complimentary investment strategies and that by switching between them investors can successfully time the country style of investment.

Haugen and Baker (1996) consider five countries: France, Germany, Japan, the United Kingdom and the United States from 1985 to 1993 and use twelve firm-specific style factors to develop an expected returns model. By using a timing model to predict style payoffs and combining the results with attribute values, they are able to successfully predict share returns.

Coggin (1998) examines size style indices, from 1963 to 1996 and value and growth style indices from 1975 to 1996, in the US. The random walk model cannot be dismissed as a suitable model for the style indices' returns and hence, Coggin (1998) concludes that styles cannot be predicted purely on the basis of the time series of values. It is not suggested that style indices are unpredictable, just that that they are unpredictable when the relevant information set is limited to the time series of returns.

Indro, Jiang, Hu and Lee (1998) study actively managed funds in the US over the period from 1993 to 1995 and find that funds which are inconsistent in both their value-growth and size styles are the worst performing funds. However, they also note that funds that exercise changes in either style perform no better than funds that are consistent in their styles.

Levis and Liodakis (1999) study UK style indices from 1968 to 1997 and find that style rotation is highly successful for size-based investment styles, but only marginally successful for value-growth based styles. The implication is that whilst style consistency may be prudent for long-term investment, style rotation can successfully enhance value.

Lucas, van Dijk and Kloek (2001) consider US data from 1984 to 1999 and find considerable time variation in the size and book-to-price effects. They find that the variation from positive to negative payoffs is partially predictable through business cycle and statistical indicators, but that business cycle indicators perform better. The resultant style rotating investment strategy, based on business cycle indicators, is found to produce robust and significant excess returns.

Barberis and Shleifer (2003) predict that style-based investment strategies are profitable through a theoretical proof and discussion, which assumes that that assets in the same style co-move too much and that assets in different styles co-move too little. They also predict that style returns exhibit a rich pattern of own and cross-correlations.

Wang's (2003) study of US data from 1960 to 2001 finds an ability of style rotation and style momentum strategies to generate abnormal excess returns. The momentum strategy is simply to buy the 'winners' and short sell the 'losers', when portfolios are ranked on a monthly basis according to return. Wang (2003) argues that the covariances between the rotating betas and the individual factors are the source of value in multifactor dynamic style strategies.

3.9. Summary and Conclusion

The concept of an efficient market i.e. a market where at any time, an asset's price fully reflects the available information, gives rise to asset-pricing theory. In an efficient market, is should be possible to accurately model an asset's return generating process. The joint hypothesis problem gives rise to a situation whereby any test of market efficiency is also a test of the asset-pricing model employed in the study. The literature tends to support market efficiency in Fama's (1970) semi-strong form, with numerous event studies supporting the notion that markets adjust quickly and without bias to new public information.

Most authors tend to support the notion that failed tests of the EMH are the result of asset-pricing model misspecification rather than inefficient markets. In empirical tests, the CAPM beta does not explain the variation in returns to the same extent achieved by so-called 'anomalous factors'. MacKinlay (1995) suggests that deviations from the CAPM are best described as either 'risk-based' or 'non-risk based'. Reinganum (1981) purports that the CAPM is misspecified because of prolonged abnormal returns, and Fama and French (1992; 1993) suggest that perhaps the observed anomalous variables proxy for an unobserved risk factor. Data snooping, survivorship bias, look-ahead bias, market frictions and investor irrationality are all cited as possible non-risk based explanations for deviation from the CAPM.

The ICAPM is accepted as a useful asset-pricing tool, which can allow partially hedged foreign investment and include currency risk factors. Empirical evidence is split, with some authors identifying increased market integration, which supports the notion of a world market portfolio and other authors identifying significant home investment preference, which diminishes the importance of the world market and currency exposures. Global risk diversification is addressed and whilst most authors identify clear risk reduction benefits in diversifying from developed into emerging markets, such diversification is not as widely practiced as expected. Explanations include un-diversifiable currency risk and high correlation in bear markets.

The methods for choosing the APT model factors are discussed under the guises of statistical and structural methods. Statistical methods, such as factor analysis, are widely criticised for factor dredging and a lack of economic interpretability, whilst structural methods are criticised by Robertson (2002) for having little empirical viability, owing to the lack of method or process for picking the factors.

Numerous anomalous factors are found to be persistently significant across varying markets. The size, earnings-to-price and book-to-market value effects are found to be intrinsically linked and it is suggested that they combine to proxy for some unidentified risk factor. A reversal in the size effect is noted in the 1990s and is reasoned by Chan, Karceski and Lakonishok (2000) to be the result of technological economies of scale, which were only attainable by larger firms in an e-commerce dominated era. The January effect is found to be significant and tends to account for a large proportion of any observed size effect. The January seasonal is also found to be pertinent to the debt-to-equity and dividend yield effects. April and December seasonals are also identified as well as the 'sell in May and go away' effect. The most popular explanation for such seasonal effects is the tax-loss-selling hypothesis because of the tax-year end. However, several countries exhibit seasonal effects at other times of the year, casting doubt on this explanation. Style-based investment is found to be inconsistent, with firms routinely changing their size style and swapping between value and growth style portfolios. However, numerous authors construct successful style-rotating strategies and argue that style rotation can significantly enhance value.

The literature provides insight into the dynamics of asset pricing. The limited success of traditional asset-pricing models, such as the CAPM, gives rise to the study of so-called anomalous factors. Through their persistency over time, these anomalies necessitate further enquiry so as to identify the, as yet, unobserved systematic risk factors at an academic level, and to enhance profitability at a practitioner level.

-4-

Data and Descriptive Statistics

"You can use all the quantitative data you can get, but you still have to distrust it and use your own intelligence and judgment."

-Toffler (1992)

4.1. Introduction

This chapter presents the data, which is used in the statistical tests for the remainder of the study. The data comprises two subsets: the market and sector returns data and the sector-specific attributes data. The biases that can arise in financial data are discussed and various adjustments are described and applied so as to help reduce the influence of these biases. Descriptive statistics are then presented for all the sector-specific attributes under consideration.

Section 4.2 presents the data set and discusses the pertinent statistical biases and adjustments made to the data. Section 4.3 discusses the descriptive statistics for the sector-specific attribute data and section 4.4 summarises and concludes.

4.2. Data

Market and sector returns data and sector-specific attributes data were obtained through the Datastream International terminal in the Department of Management Studies at the University of Cape Town. Monthly data was collected for the period from 1 January 1993 to 31 December 2005. The first two years of data is used to calculate momentum and growth variables. The in-sample period is the seven year period from 1 January 1995 to 31 December 2001 and the out-sample period is the four year period from 1 January 2002 to 31 December 2005.

There are a maximum of 38 International Classification Benchmark (ICB) sector (level four) indices that are calculated for the 48 countries listed on Datastream International. The number of sector indices, calculated for each of the observed countries, varies depending on the country. A full summary is given in appendix A.4.

Market indices (ICB level 1) are available for all 48 countries whilst 1213 sector indices, out of a possible 1824, are available across the countries.

4.2.1 Statistical Biases

The literature highlights the need for prudence in statistical testing. Tests at an individual stock level are often criticised because of look-ahead bias, infrequent trading bias, outliers, survivorship bias and data-snooping bias. Hence, the impact and relevance of these various biases are discussed in relation to market and sector index returns, as opposed to individual share returns, and furthermore the issue non-uniformity between markets is also considered.

4.2.1.1. Look-Ahead Bias

Look-ahead bias arises when it is assumed that financial information was available to investors before it was published or announced. The data is biased because investors are assumed to be able to make more informed decisions than they were actually capable of. Such bias can occur when considering financial statements: there will always be a lag between the financial year end and the publishing of the financial statements. Look-ahead bias is induced if it is assumed that the information contained in the financial statements was available at the financial year-end.

The literature suggests lagging the attribute data with respect to the returns data (see Banz and Breen 1986, and Van Rensburg and Robertson 2003) in order to allow for the real-life lags in information arrival. Datastream International only records data in the period when it becomes freely publicly available and therefore the data should be free of look-ahead bias. However, as a precautionary measure, the attribute data is lagged by one month with respect to the returns data for the tests of chapters 6 and 9.

4.2.1.2. Infrequent Trading Bias

Infrequent trading bias typically arises in two forms: non-synchronous trading and non-trading. Non-synchronous trading bias arises when shares are always assumed to trade at the same time; in practice share prices will be determined at different points in time and the latest recorded prices for two shares may have originated at very different points in time. Non-trading occurs when a share does not trade in a period, resulting in out-of-date prices.

Infrequent trading bias can significantly affect the empirical results of a study at the individual stock level (see Fama 1965, Fisher 1966, Scholes and Williams 1977, and Dimson 1979). However, it is reasoned that infrequent trading bias will not affect the empirical results of this study because sectors are being considered and it is highly unlikely that all the shares in a sector will be thinly traded in any chosen month. Further to the proposed irrelevance of the effect, a suitable measure of trading frequency is not available at a sector level. Individual shares can be filtered for thin trading (see Van Rensburg and Robertson 2003) by calculating the trading volume ratio and only including those shares with trading volume ratios greater than 0.01%. Whereas Datastream International does provide turnover by volume (VO) and turnover by value (VA) figures for each sector, it does not provide the total number of shares in issue in each sector and hence the ratio cannot be calculated.

4.2.1.3. Outliers

Outliers and influential observations are abnormal observations, which may occur as the result of extremely irregular events or simply because of errors from the data source. Outliers and influential observations distort statistical tests and can therefore affect results. Influential observations lie far from the mean of both the explanatory and response variables and as a result have a strong influence on the slope coefficients in ordinary least squares (OLS) regressions. Outliers lie far from the response variable mean and can therefore influence the intercept in OLS regressions. Double winsorisation is used to counter the effects of outliers and influential observations; the procedure is discussed in section 4.2.2.1.

4.2.1.4. Survivorship Bias

Survivorship bias arises in test results because poorly performing companies tend to enter liquidation and suffer de-listing whilst companies that perform well, remain listed. Whereas share returns are not specifically examined in this study, survivorship bias in the shares will in turn bias the market and sector indices. The market and sector indices comprise the listed companies at the time and will evolve through time, only reflecting the performance of those shares that remain listed.

4.2.1.5. Data-Snooping Bias

Data snooping arises from the repeated testing of data for factor significance, where factors have been previously identified. This study could be subject to data snooping because some of the factors under consideration have been identified as significant in previous studies. However, others are simply constructed from the available sector-specific variables and no pre-judgments are put into their selection. Kennedy (2003) argues that economic theorising should take place before variables are tested for economic value so that there are valid economic reasons for their inclusions. However, it should be recognised that some effects such as the 'size' effect have no clear economic interpretation and yet have been shown to exist in the literature. Consequently, if the data set were narrowed to only those attributes which can be explained, then the study would add less value than it would if all the attributes were included, with the chance of finding new significant variables.

4.2.1.6. Non-Uniformity of Data Across Markets

Non-uniformity in a data set, which covers several markets, arises from differences in economic constructs between the markets. The most obvious economic example is the construction of market and sector indices in different currencies. To combat this incompatibility, all index data is converted to US Dollars, using the ruling spot rate of exchange, before computation of the returns (see appendix A.1 for details of the sources of the exchange rates used). A subtler example is the method of constructing the indices used across the different markets; government, economic and financial institutions have different methods of index construction and whereas one may use a market-value-weighted approach, another may use any equally-weighted approach. This study is not subject to such inconsistencies because Datastream International constructs all the indices in the data set in the same manner i.e. index classification is consistent across markets, all indices are constructed using a market-value-weighted approach and irregular events, such as stock splits, are dealt with using the same procedure.

It is suggested that numerous non-uniformity biases will still persist in the data including the varying degrees of risk associated with different political environments, varying legal constructs, capital mobility, monetary and fiscal policy, market liquidity and currency stability.

4.2.2 Market and Sector Return Data

Market and sector returns data is obtained from Datastream International for the period from 31 January 1993 to 31 December 2005. The first two years worth of data is not tested, but merely used to calculate momentum and growth variables. Datasteam provides a returns index (RI) for each market and sector, which weights the returns indices for all the constituent shares by their market capitalisation. The individual total returns indices for the constituent shares include both the capital gains and the dividend yields for all the listed shares, and are also adjusted for the effects of capital events such as stock splits. Dividends are assumed to be reinvested in the same stock on the ex-dividend date.

In order to standardise the various sectors from the 48 different countries, all the market and sector return indices are converted from their local currency to US Dollars. Spot exchange rates are used to make the currency conversions for all markets; the sources of the various exchange rates are given in appendix A.1. For the Euro-Zone countries, exchange rates for the old currencies have been used up until the end of 1998 and simulated rates have been used from 1 January 1999, when the exchange rates of the various countries were pegged to the Euro. The simulated rates are calculated by taking the fixed rate of the Euro-Zone currency to the Euro and then multiplying it by the Euro-US Dollar exchange rate. The total return for a market / sector in month t is given by $(RI_t - RI_{t-1}) / RI_{t-1}$ where RI_t and RI_{t-1} are the returns indices in US Dollars at times t and t-1, respectively.

4.2.2.1. Adjustments to Market and Sector Returns Data

In order to remove the effects of outliers and influential observations, a winsorisation process similar to that of Velaers (2006), is applied to the returns data. The mean and standard deviation of returns are calculated across all the markets and sectors, in all the countries, in each month. All observations lying over three standard deviations from the mean value are temporarily excluded. The mean and standard deviation are recalculated without the old outliers, which along with any new outliers, are then truncated to exactly three standard deviations from the new mean. Finally, the returns data are limited to 100% in absolute value. The technique has the advantage of retaining all the available data points, whilst at the same time ensuring robust regression results which are not heavily influenced by outlying or influential observations.

4.2.3 Sector-Specific Attribute Data

Sector-specific attribute data (also referred to as anomalies, characteristics, style characteristics and variables) is obtained from Datastream International for the period from 31 January 1993 to 31 December 2005. Once again, the first two years of data is merely used to calculate momentum and growth variables and is not actually tested. Datastream International calculates sector-specific attribute data by weighting the individual stock attributes by their market capitalisations. These stock attributes include accounting line items (such as market value), accounting ratios (such as cash earnings to book value) and technical indicators (such as *n*-month return momentum). Datastream International derives its firm-specific, and in turn its sector-specific, attributes data from the quoted published financial statements of listed companies, using consolidated reports when available and parent financials when necessary.

35 sector-specific attributes are examined in this study and whilst some have previously been tested on some of the markets under consideration, the majority have not. The attributes under consideration are listed in table 4.1, along with their respective style group, code, characteristic and formula. Some attributes are simply taken directly from Datastream International (such as dividend yield), whilst others are constructed using Datastream International information (such as three month growth in market value traded to market value). Both the raw data variables obtained from Datastream International and those constructed variables which are not directly tested, are listed at the bottom of the table for easy reference. The codes for the momentum and growth attributes include a hyphen and the number of months over which the growth occurred. For example, the three-month momentum in sector returns is coded as MOM-3, whilst the twelve-month growth in dividends to price is coded as D-12P. If a formula is not given for a specific attribute, for example, dividend yield (DY), then it is because the attribute has been calculated by Datastream International and a full definition can be found in appendix A.5.

The size effect is tested using the natural log of the market value (LNMV) of the various sectors, across all the countries. The natural log is applied to the market value attribute data to ensure that the data is normally distributed. Whereas it is not a requirement of OLS regression (used in the chapter 6 and 9 tests) that the explanatory variables be normally distributed, the natural log transform does serve to further reduce the effects of outliers and influential observations, which may be erroneous or caused by abnormal events.

One-month, three-month, six-month, one-year and two-year changes in the size and liquidity, and momentum attributes are calculated since these attributes are based on variables which change frequently and can be easily observed in the market. Six-month, one-year and two-year changes in the growth attributes are calculated since these attributes are based on variables, which are reported less frequently through interim financial statements.

The cash earnings and earnings can take on negative values, which is problematic when calculating growth in these attributes. For example, if an attribute A, goes from being negative to positive, the percentage change will turn out negative if calculated using the standard change formula: [A(t)-A(t-n)] / A(t-n). In addition, these variables can take on zero values, which could cause division by zero discontinuities in the data. As a result, the denominator is replaced with the current price index PI(t) to give [(A(t)-A(t-n)] / PI(t) and the formula is interpreted as the *n* month growth in attribute A, to Price. The growth in dividends is calculated in a similar fashion for consistency with the other growth attributes; it is recognised that dividends cannot take on negative values but could theoretically be zero (though very unlikely for a whole sector) in a particular month, causing discontinuities in the standard growth formula.

Missing observations in the attribute data can be dealt with in a variety of ways. Haugen and Baker (1996) suggest assigning the mean attribute value to months where attribute data is missing. However, it is recognised that this approach may introduce statistical biases and hence months with missing attribute data are simply omitted in this study.

Appendix A.1 displays the sources of the exchange rates used. Appendix A.2 displays the ICB market and sector classifications. Appendix A.3 displays the 48 countries under consideration. Appendix A.4 displays the data availability of the various market and sector indices by country. Appendix A.5 displays the Datastream International variable definitions and abbreviations. Appendix A.6 displays the data availability of the market index data by country and year. Appendix A.7 displays the data availability of the sector index data by country and year.

Table 4.1: Sector-Specific Attributes

The table shows the 35 sector-specific attributes under consideration in this study. The attributes are listed according to style group, code, characteristic and formula. The codes for the momentum and growth attributes include a term comprising a hyphen and the number of months over which the growth occurred. If a formula is not given for a specific attribute then it is because the attribute has been calculated by Datastream International and a full definition can be found in appendix A.5.

Style Group	Code	Characteristic	Formula
Value	BP	Book Value per Share to Price	1 / PB
	CP	Cash Earnings per Share to Price	1 / PC
	DY	Dividend Yield as a Percentage	DY
	EY	Earnings Yield	1 / PE
Growth	C-6P	6-month growth in Cash Earnings, to Price	[C(t)-C(t-6)] / PI(t)
	C-12P	12-month growth in Cash Earnings, to Price	[C(t)-C(t-12)] / PI(t)
	C-24P	24-year growth in Cash Earnings, to Price	[C(t)-C(t-24)] / PI(t)
	CB	Cash Earnings to Book Value	[1 / PC] * PB
	DC	Dividends to Cash Earnings	DY / 100 * PC
	D-6P	6-month growth in Dividends, to Price	[D(t)-D(t-6)] / PI(t)
	D-12P	12-month growth in Dividends, to Price	[D(t)-D(t-12)] / PI(t)
	D-24P	24-month growth in Dividends, to Price	[D(t)-D(t-24)] / PI(t)
	E-6P	6-month growth in Earnings, to Price	[E(t)-E(t-6)] / PI(t)
	E-12P	12-month growth in Earnings, to Price	[E(t)-E(t-12)] / PI(t)
	E-24P	24-month growth in Earnings, to Price	[E(t)-E(t-24)] / PI(t)
	PO	Payout Ratio	DY /100 * PE = DE
	ROE	Return on Equity	[1 / PE] * PB = EB
Momentum	MOM-1	1-month prior return	[RI(t)-RI(t-1)] / RI(t-1)
	MOM-3	3-month prior return	[RI(t)-RI(t-3)] / RI(t-3)
	MOM-6	6-month prior return	[RI(t)-RI(t-6)] / RI(t-6)
	MOM-12	12-month prior return	[RI(t)-RI(t-12)] / RI(t-12)
	MOM-18	18-month prior return	[RI(t)-RI(t-18)] / RI(t-18)
Size & Liquidity	LNMV	Natural Log of Market Value	LN[MV]
	MVTMV	Market Value Traded to Market Value	[VO * 1 000 * PI] / [MV * 1 000 000]
	MVTMV-1	1-month growth in MVTMV	[MVTMV(t)-MVTMV(t-1)] / MVTMV(t-1)
	MVTMV-3	3-month growth in MVTMV	[MVTMV(t)-MVTMV(t-3)] / MVTMV(t-3)
	MVTMV-6	6-month growth in MVTMV	[MVTMV(t)-MVTMV(t-6)] / MVTMV(t-6)
	MVTMV-12	12-month growth in MVTMV	[MVTMV(t)-MVTMV(t-12)] / MVTMV(t-12)
	MVTMV-24	24-month growth in MVTMV	[MVTMV(t)-MVTMV(t-24)] / MVTMV(t-24)
	VO-1	1-month growth in Turnover by Volume	[VO(t)-VO(t-1)] / VO(t-1)
	VO-3	3-month growth in Turnover by Volume	[VO(t)-VO(t-3)] / VO(t-3)
	VO-6	6-month growth in Turnover by Volume	[VO(t)-VO(t-6)] / VO(t-6)
	VO-12	12-month growth in Turnover by Volume	[VO(t)-VO(t-12)] / VO(t-12)
	VO-24	24-month growth in Turnover by Volume	[VO(t)-VO(t-24)] / VO(t-24)
Risk	SIGMA	Volatility in 12-month prior returns	Std. Dev. of [Ret(t), Ret(t-1), ..., Ret(t-12)]

Datastream Raw Data

Code	Characteristic
DY	Dividend Yield
MV	Market Value
PB	Price to Book Value per Share
PC	Price to Cash Earnings per Share
PE	Price to Earnings per Share
PI	Price Index
RI	Returns Index
VO	Turnover by Volume

Constructed

Code	Characteristic	Formula
C	Cash Earnings per Share	[1 / PC] * PI
D	Dividends per Share	DY /100 * PI
E	Earnings per Share	[1 / PE] * PI
Ret	Monthly Return	[RI(t)-RI(t-1)] / RI(t-1)

4.2.3.1. Adjustments to Sector-Specific Data

Deakin (1976) considers the assumption of normality in the distributions of financial accounting ratios. He finds that most ratios are not normally distributed at an individual share level, and whereas he does not specify the relevant transformation for every situation, he does suggest that the square root and natural log transforms may be useful in attaining normality in the data. He does however find that ratios tend to be normally distributed within industry groups and this implies that the sector ratios, which are simply market weighted averages of the individual ratios, should be normally distributed.

Frecka and Hopwood (1983) extend the work of Deakin (1976): using the same ratios they examine the effect of outliers in the data and find that in most cases non-normality is the result of outliers. By deleting the outliers, Frecka and Hopwood (1983) are able to achieve normality or approximate normality in most cases. They find similar results at an industry level.

Foster (1986) is less brusque in dealing with outliers and suggests deletion of true outliers (errors as opposed to abnormal events), winsorisation of outliers so that they are less extreme, and trimming the tails of the distribution to bring the kurtosis in line with the normal distribution.

So (1987) finds that outliers are not the only cause of non-normality in ratio data and that even after removing the outliers, the data is non-normally distributed and in most cases skew.

It is not a requirement of OLS regression that the explanatory variables be normally distributed but as pointed out in the literature, outliers can severely influence the results (see Frecka and Hopwood 1983 and So 1987).

The sector-specific attribute data is adjusted for the effects of outliers and influential observations by employing a similar winsorisation technique to that used in section 4.2.2.1 to adjust the market and sector returns data. The mean and standard deviation for each attribute are calculated across all the sectors and all the countries in each month, and observations lying over three standard deviations from the mean value are temporarily excluded. The mean and standard deviation are recalculated without the old outliers, which along with any new outliers, are then truncated to exactly three standard deviations from the new mean. The 100% limitation is not applied to the sector-specific attribute data. However, the sector-specific attribute data is standardised (the mean and standard deviation are scaled to zero and one, respectively) to facilitate direct comparison between the regression coefficients in the cross-sectional regressions of chapters 6 and 9.

4.3. Descriptive Statistics

The sheer size and diversity of the data limits the number of useful statistics and summary measures that may be employed. Descriptive statistics are calculated for each of the 35 sector-specific attributes on a monthly basis across all 38 level 4 sectors in all 48 countries. The statistics are computed after the winsorisation process described in section 4.2.3.1 but before standardisation.

The mean of the monthly means, the mean of the monthly standard deviations and the mean of the monthly medians are all calculated for each attribute for both the in-sample and out-sample periods. In addition, the maximum and minimum monthly means are calculated for each attribute over the whole testing period. The in-sample period covers the seven years from January 1995 to December 2001, whilst the out-sample period covers the four years from January 2002 to December 2005. The results are presented in table 4.2 in style group order as in table 4.1 for ease of comparison.

Whilst the distribution of the data does not influence the tests of chapters 6 and 9 (since normality is neither assumed nor required), it is observed that the majority of the means of the monthly medians are less than the means of monthly means. The result is skewness to the right in most of the attribute data. The only exceptions to the prevailing right skewness appear to be a few growth variables and the natural log of market value (LNMV).

Table 4.2: Descriptive Statistics

The table shows the mean of monthly means, mean of monthly standard deviations, mean of monthly medians, maximum of monthly means and minimum of monthly means for all 35 sector-specific attributes, with the former three statistics being calculated for both the in and out-sample periods. All 38 level 4 sectors are considered across all 48 countries.

Attribute	Mean of Means		Max of Means	Min of Means	Mean of Standard Deviations		Mean of Medians	
	In-Sample	Out-Sample			In-Sample	Out-Sample	In-Sample	Out-Sample
BP	0.623	0.642	0.858	0.466	0.422	0.377	0.519	0.567
CP	0.146	0.156	0.211	0.110	0.105	0.100	0.117	0.132
DY	2.024	2.307	2.714	1.676	1.778	1.908	1.670	1.988
EY	0.065	0.068	0.088	0.052	0.043	0.042	0.057	0.061
C-6P	0.001	0.009	0.030	-0.017	0.049	0.039	0.001	0.006
C-12P	0.001	0.016	0.034	-0.023	0.076	0.057	0.004	0.013
C-24P	0.006	0.023	0.043	-0.019	0.089	0.083	0.010	0.023
CB	0.279	0.271	0.311	0.241	0.228	0.157	0.243	0.248
DC	0.178	0.193	0.236	0.154	0.163	0.182	0.141	0.153
D-6P	0.000	0.002	0.003	-0.002	0.007	0.008	0.000	0.001
D-12P	0.000	0.003	0.005	-0.003	0.011	0.013	0.000	0.002
D-24P	0.001	0.004	0.008	-0.003	0.016	0.019	0.001	0.003
E-6P	0.000	0.004	0.010	-0.007	0.022	0.027	0.000	0.003
E-12P	0.001	0.006	0.016	-0.010	0.033	0.039	0.002	0.007
E-24P	0.004	0.008	0.024	-0.009	0.043	0.050	0.006	0.010
PO	0.359	0.390	0.453	0.307	0.307	0.378	0.316	0.328
ROE	0.125	0.124	0.150	0.109	0.089	0.086	0.110	0.110
MOM-1	0.003	0.017	0.095	-0.159	0.090	0.070	0.001	0.015
MOM-3	0.011	0.055	0.215	-0.197	0.166	0.132	0.004	0.048
MOM-6	0.024	0.114	0.359	-0.218	0.247	0.206	0.011	0.098
MOM-12	0.073	0.222	0.773	-0.196	0.387	0.346	0.036	0.185
MOM-18	0.139	0.324	0.916	-0.250	0.493	0.484	0.076	0.257
LNMV	6.714	6.909	7.399	6.422	2.997	2.948	7.038	7.264
MVTMV	25.991	210.221	3928.989	0.049	349.599	2640.238	0.017	0.025
MVTMV-1	0.556	0.583	3.856	-0.622	1.848	1.690	0.017	0.052
MVTMV-3	0.660	0.628	4.118	-0.611	2.022	1.887	0.049	0.047
MVTMV-6	0.867	0.923	6.266	-0.586	2.488	2.646	0.086	0.122
MVTMV-12	1.070	0.979	5.598	-0.207	2.987	2.870	0.131	0.104
MVTMV-24	1.870	1.407	4.766	-0.085	4.634	4.274	0.333	0.137
VO-1	0.573	0.600	4.101	-0.622	1.885	1.722	0.021	0.057
VO-3	0.725	0.689	4.132	-0.606	2.204	2.049	0.063	0.056
VO-6	0.996	1.043	6.339	-0.587	2.800	2.963	0.115	0.143
VO-12	1.366	1.194	5.181	-0.109	3.712	3.502	0.200	0.138
VO-24	2.716	1.956	6.579	0.057	6.732	5.814	0.501	0.221
SIGMA	0.090	0.078	0.121	0.062	0.037	0.031	0.084	0.074

4.4. Summary and Conclusion

The market and sector returns data set and the sector-specific attributes data set are presented in this chapter and used in the remainder of the study. The statistical biases that could affect the data are discussed and remedies are suggested to counter the biases. Look-ahead bias is addressed by lagging the independent variables with respect to the dependent variables in all the OLS regression tests of chapters 6 and 9. Non-uniformity in the data across the various markets is partially addressed by converting all the indices to US Dollars before calculating the returns or performing the OLS regression tests. Survivorship bias and data-snooping bias will still affect the results as market and sector indices will comprise only those firms that survive the sample period and some attributes have been previously tested or may be construed as not having an economically interpretable reason for inclusion.

Both data sets are adjusted for outliers and influential observations by double winsorisation. The market and sector returns data is further limited to 100% in absolute value, whilst the sector-specific attribute data is standardised to allow comparability of the regression coefficients in chapters 6 and 9. The sector-specific attributes are presented in their style groups and descriptive statistics for each attribute are also displayed.

-5-

Exploratory Analysis and Market Risk Decomposition

"We shall not cease from exploration and the end of all our exploration will be to arrive where we started and know the place for the first time."

-Eliot (1944)

5.1. Introduction

This chapter comprises two main sections: the exploratory analysis and the market risk decomposition. In the exploratory analysis, the two simplifying techniques of cluster analysis and factor analysis are employed to clarify the structure of the market returns data and derive factors for use in the Arbitrage Pricing Theory (APT) model in the market risk decomposition section. Under the market risk decomposition, the Single-Index, empirical ICAPM and Multi-Index models are presented as empirically testable versions of the Capital Asset Pricing Model (CAPM), the International CAPM (ICAPM) and the APT model, respectively. The three asset-pricing models are then used to risk-adjust the sector returns for the chapter 6 tests.

Section 5.2 discusses the data and methodology, whilst section 5.3 displays and discusses the empirical results and section 5.4 summarises and concludes.

5.2. Data and Methodology

5.2.1 Exploratory Analysis

Cluster and factor analyses are performed on the monthly returns generated by the International Classification Benchmark (ICB) market (level 1) indices of all 48 countries under consideration and the monthly returns generated by the FTSE World, FTSE Developed and FTSE Emerging Market indices. The analyses serve to identify sources of common variation in the monthly returns generated by the sector (ICB level 4) indices of the 48 countries under consideration. The market indices are considered over the out-sample period from 31 January 2002 to 31 December 2005.

Figure 5.1 displays the evolution of the total market value, in US Dollars, of the developed and emerging markets under consideration over the out-sample period from 31 January 2002 to 31 December 2005.

Figure 5.1: Evolution of the Total Market Value of Developed and Emerging Markets

The figure displays the evolution of the total market value, in US Dollars, of the developed and emerging markets under consideration over the out-sample period from 31 January 2002 to 31 December 2005.

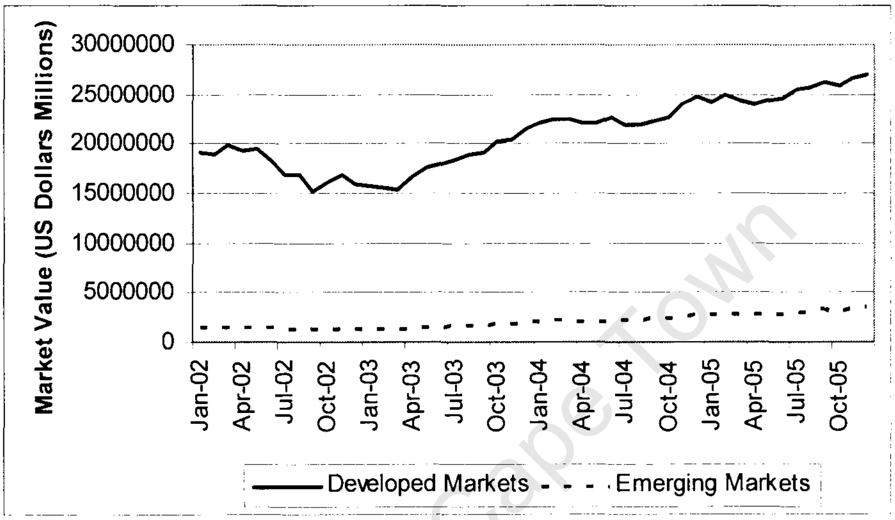
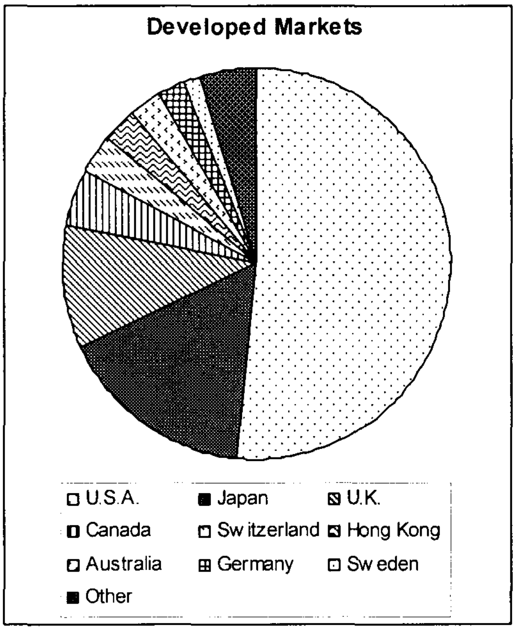


Figure 5.2 displays the composition of the total market value, in US Dollars, of both the developed and emerging markets under consideration as at 31 December 2005. Table 5.1 shows the total market values, in millions of US Dollars, of all the markets at the same date.

Figure 5.2: Composition of the Total Market Value of Developed and Emerging Markets as at 31/12/2005

The figure displays the composition of the total market value, in US Dollars, of both the developed and emerging markets under consideration as at 31 December 2005.



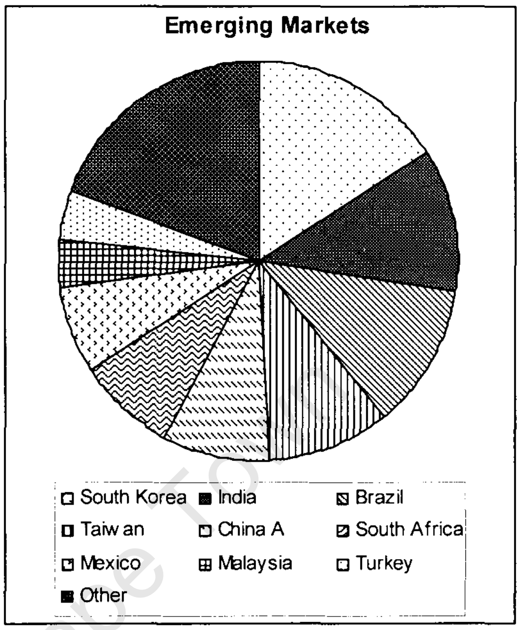


Table 5.1: Total Market Value of Developed and Emerging Markets as at 31/12/ 2005

The table shows the total market values, in millions of US Dollars, of all the developed and emerging markets under consideration as at 31 December 2005.

Developed Markets	Market Value (USD mil.)	Emerging Markets	Market Value (USD mil.)
U.S.A.	13933710	South Korea	550808
Japan	4425921	India	407994
U.K.	2749421	Brazil	407581
Canada	1212195	Taiwan	350988
Switzerland	922050	China A	295694
Hong Kong	777933	South Africa	284731
Australia	720267	Mexico	237841
Germany	625289	Malaysia	142372
Sweden	366520	Turkey	128583
France	255116	Chile	111010
Netherlands	247107	Thailand	97389
Singapore	183447	Israel	85477
Norway	177597	Poland	77597
Denmark	163223	Indonesia	69774
Ireland	141230	Columbia	42437
New Zealand	38751	Czech Republic	37935
Finland	33504	Philippines	36471
Austria	9690	Hungary	32613
Belgium	6713	Argentina	23506
Spain	3930	China	20248
Luxembourg	866	Peru	18877
Italy	407	Russia	15918
Greece	364	Cyprus	6365
Portugal	354	Venezuela	5473

5.2.2 Cluster Analysis

Cluster analysis forms groups of similar objects by using an agglomerative hierarchical clustering algorithm whereby clusters are formed by grouping objects into bigger and bigger clusters until all the objects are members of a single cluster (Norušis, 1994). The aim of cluster analysis is to create clusters of objects with strong association within clusters and weak association between clusters. The technique is purely descriptive in nature and does not provide any inferences as to the structures derived. In this study the objects under consideration are the time series of monthly returns generated by the 51 market indices (48 country market indices and three FTSE World, Developed and Emerging market indices).

The agglomerative algorithm begins by considering each time series of returns as a separate cluster i.e. there are as many clusters as there are time series. At every subsequent step clusters are combined according to the measure of similarity and the method of clustering chosen. There are a variety of similarity measures and clustering methods, which may be employed in the analysis. The decision as to which measure and method are most appropriate depends on the nature of the objects under consideration and the clarity of the results, respectively.

The Pearson (1896) correlation (referred to as the 'correlation' for the remainder of this chapter) coefficient is used as the measure of similarity in clustering the time series of returns and is defined as:

$$\rho_{x,y} = \frac{\sum_{t=1}^{n}(r_{x,t} - \bar{r}_x)(r_{y,t} - \bar{r}_y)}{n-1} \tag{5.1}$$

Where $\rho_{x,y}$ is the correlation coefficient between the time series of returns of the market indices x and y

$r_{x/y,t}$ is tth monthly return derived from market index x/y

$\bar{r}_{x/y}$ is the mean monthly return for the time series of returns derived from market index x/y

n is the number of monthly return observations in the time series

The correlation coefficient is the most appropriate measure of similarity because market indices are being clustered into homogenous groups using only one variable, the monthly return. Other measures such as Euclidean distances and Chebychev absolute distances (see Norušis, 1994) are not considered, since they lend themselves to a multivariable setting where clusters are formed according to the multidimensional distance between objects and are less powerful than the correlation coefficient in a single-variable space.

Ward's method is used to form the clusters because it is very sensitive to the clustering variable and hence produces very 'tight' clusters, which allow a greater level of clarity when there is only one clustering variable which does not exhibit large variation. "Ward's method combines clusters with the smallest increase in the overall sum of the squared within-cluster distances" (Norušis, 1994).

The results of the cluster analysis are displayed in tree diagrams, which can only be interpreted by inspection. Any inferences drawn from inspection of the tree diagrams are susceptible to a degree of subjectivity since arbitrary cut-off distances define the number of clusters observed. Consequently, a level of practical reasoning is employed to rationalise the number of clusters extracted and their nature.

5.2.3 Factor Analysis (using Principal Components)

"Factor analysis is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables" (Norušis, 1994). Factor analysis is useful in the context of this study in that it allows for inferences to be made regarding the structure of the relationships between the market indices, thereby supporting and clarifying the results of the cluster analysis. Furthermore, a more parsimonious set of factors can be derived to represent the much larger set of market indices and market index proxies can then be found to replace the derived factors. Replacing the derived factors with market proxies allows for a small set of summary indices to be found, which represent the original market indices whilst providing the real-world economic interpretability that the derived statistical factors do not possess. The small set of representative market proxies thus lend themselves to inclusion in a multifactor APT model for asset pricing.

There are numerous methods of factor extraction including principal components, maximum-likelihood and various least-squares methods. The principal components methodology is used in this study since it produces uncorrelated factors and generally accounts for a greater percentage of the total variance in the variables.

The principal components method involves creating a number of linear combinations of the original variables. The first principal component to be extracted is that combination which accounts for the greatest percentage of the total variance. The second principal component is that combination which accounts for the second greatest percentage of the total variance whilst being uncorrelated with the first principal component (Norušis, 1994). The process continues until the final factor extracted explains no greater proportion of the total variance than any single variable would do i.e. until the Eigenvalue of the last factor is 1.

Van Rensburg and Slaney (1997, p.6) highlight that the decision regarding how many factors should be extracted must made by considering the "trade-off between the parsimony offered by a smaller number of factors and the increased explanatory power that results as more factors are extracted." The Eigenvalue of a factor measures the total variance captured by the factor and thus its explanatory power. Hence, Cattell (1966) developed the Scree plot as a tool to use in the factor extraction decision. The Eigenvalue associated with each factor is plotted on the vertical axis whilst the factors are plotted on the horizontal axis. Hair, Anderson, Tatham and Black (1992) suggest that the last factor to be extracted is the factor at which the Scree plot first starts to 'flatten out', whilst Cattell and Jaspers (1967) suggest the last factor before the Scree plot 'flattens out'.

Factor loadings are calculated for each market index on every factor extracted. The loadings indicate how much weight is assigned to each factor when the market index is expressed as a linear combination of the factors. "Factors with large coefficients (in absolute value) for a variable [market index] are closely related to the variable [market index]" (Norušis, 1994). In the special case where factors are uncorrelated with each other, such as in this study using the principal components methodology, the factor loadings are actually the correlations between the market indices and the factors. Hair, Anderson, Tatham and Black (1992) and Tabachnick and Fidell (1983) suggest a factor loading of 0.30 to be a significant correlation between the variable and the factor.

When examining factor loadings it is often found that many variables exhibit significant correlation with most factors. This situation is not ideal as it defeats the goal of factor extraction: deriving a set of parsimonious factors, which represents sets of closely related variables. In order to rectify this situation, the axes of the original factor loadings matrix are rotated so that variance explained by each factor is redistributed so as to minimize the number of variables that have high loadings on any particular factor (Norušis, 1994). Three rotation methods are employed in this study: the Varimax raw and normalised orthogonal rotations and the Promax oblique rotation. The rotations differ in that the orthogonal rotations maintain the rotated axes at right angles and hence ensure that the factors are uncorrelated, whilst the oblique rotation allows the axes to deviate from their original orthogonal orientation and induce correlation between the factors. Whilst the distinct uncorrelated factors derived from the orthogonal rotations may be useful and convenient, they tend to not reflect the economic reality of partial correlation. Hair, Anderson, Tathom, and Black (1992) describe the oblique rotation as more accurate since each rotated axis is closer to the respective group of variables than it would be if strict right angles were maintained between the axes. "Oblique rotations have often been found to yield substantively meaningful factors" (Norušis, 1994).

5.2.4 Model Construction

5.2.4.1. The Single-Index Model

The Single-Index model is used to empirically test the theoretical CAPM as outlined in section 2.3.2.2. Notationally, the model can be expressed as follows:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \varepsilon_{i,t} \tag{5.2}$$

Where $r_{i,t}$ is the observed realised monthly return on sector i at time t

$r_{m,t}$ is the observed realised monthly return on the world market index at time t

$r_{f,t}$ is the monthly risk-free rate of return at time t

α_i is the excess systematic return on sector i, unaccounted for by beta

β_i is the sensitivity of the excess return on sector i to the excess return on the world market

$\varepsilon_{i,t}$ is the unexplained residual return on sector i at time t

The FTSE World Market index is used as a proxy to calculate the monthly return on the world market index, whilst the monthly rate of return on 90-day US treasury bills proxies for the risk-free rate of return. The FTSE Global Equity Index Series boasts a 98% coverage ratio when considering the world's total investable equity market capitalisation and as result should provide a fair proxy to the true unobservable world market portfolio (coverage available online at www.ftse.com). US treasury bills are used to determine the risk-free rate of return since all sector indices have been converted to US Dollars and hence the model tests the Dollar excess return of the sector versus the world market excess return, which is also calculated in US Dollars.

5.2.4.2. The Empirical ICAPM

An empirical ICAPM is used to test the theoretical ICAPM as outlined in section 2.3.4.2. Notationally, the model can be expressed as follows:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + \gamma_{i,BD} r_{BD,t} + \gamma_{i,JP} r_{JP,t} + \gamma_{i,UK} r_{UK,t} + \varepsilon_{i,t} \tag{5.3}$$

Where $r_{i,t}$ is the observed realised return on sector i at time t

$r_{m,t}$ is the observed realised return on the world market index at time t

$r_{n,t}$ is the observed realised return on the currency of country n relative to the US Dollar at time t

$r_{f,t}$ is the US risk-free rate of return at time t

α_i is the excess systematic return on sector i, unaccounted for by the risk premia

β_i is the sensitivity of the excess return on sector i to the excess return on the world market

$\gamma_{i,n}$ is the sensitivity of the excess return on sector i to the return on the foreign currency of country n

$\varepsilon_{i,t}$ is the unexplained residual return on sector i at time t

As for the Single-Index model in section 5.2.4.1, the FTSE World Market index is used as a proxy for the world market index and the monthly return on US treasury bills proxies for the risk-free rate of return. Solnik (2000, p.277) claims that it is sufficient to include only the returns on the major currencies under consideration, since together they tend to capture all the currency effects. To this end and in the interests of parsimony, only three currency returns are considered in the model, namely the returns on the Deutsch Mark, Japanese Yen and British Pound relative to the US Dollar. The Datastream country codes for Germany (BD), Japan (JP) and the United Kingdom (UK) are used to specify the various currency returns and sensitivities in equation 5.3. It should be noted the rate of return of the Deutsch Mark with respect to the US Dollar is directly proportional to the Euro rate of return with respect to the US Dollar during the sample period under consideration (the exchange rate between the Deutsch Mark and the Euro was fixed on 1 January 1999 and the out-sample period is from 31 January 2002 to 31 December 2005).

5.2.4.3. The Multi-Index Model

The Multi-Index model is used to empirically test the theoretical APT model as outlined in section 2.3.5.2. Notationally, the model can be expressed as follows:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \sum_{k=1}^{K} \beta_{i,k}(r_{k,t} - r_{f,t}) + \varepsilon_{i,t} \tag{5.4}$$

Where $r_{i,t}$ is the observed realised return on sector i at time t

$r_{k,t}$ is the observed realised return on factor k at time t

$r_{f,t}$ is the risk-free rate of return at time t

α_i is the excess systematic return on sector i, unaccounted for by the K betas

$\beta_{i,k}$ is the sensitivity of the excess return on sector i to the excess return on the k^{th} factor

$\varepsilon_{i,t}$ is the unexplained residual return on sector i at time t

Once again, as for the Single-Index model and the empirical ICAPM in sections 5.2.4.1 and 5.2.4.2 respectively, the monthly return on US treasury bills proxies for the risk-free rate of return.

The number of factors to be included in the Multi-Index model is determined by cluster analysis and factor analysis using the principal components methodology. The analyses are performed on the time series of monthly returns derived from the 48 country market indices, the FTSE World Market index, the FTSE Developed Market index and the FTSE Emerging Market index (all denominated in US Dollars). The out-sample period from 31 January 2002 to 31 December 2005 is the period under consideration, since it is the only period subjected to risk adjustment.

The cluster analysis is performed using the Statistica 7 software package. The cluster analysis is intended to give some idea as to the level of association between the various indices and aid in the interpretation of the factor analysis results.

The factor analysis, Scree plot and Varimax rotations are also performed using the Statistica 7 software package whilst the Promax rotation is performed using the 'R' statistical software package. The number of factors to be extracted is determined by the construction of a Scree plot. Once the number of factors has been determined, the factor analysis is conducted and the un-rotated factor loadings are then produced. Varimax (raw and normalised) and Promax rotations are then performed on the un-rotated factor loadings. In section 5.2.3 loadings obtained from the Promax rotation are reasoned to give the most meaningful factors and are thus used to determine the factor proxies. Market indices that load highly on one factor whilst loading insignificantly (loading of less than 0.30) on the rest of the factors are considered as proxies for the factor. Since more than one market index per factor tends to meet this criteria, the results of the cluster analysis and economic reasoning are employed to determine the market index factor proxies.

5.2.5 Testing Procedure

The Single-Index, empirical ICAPM and Multi-Index models in section 5.2.4 are all linear models and as such are tested using Ordinary Least Squares (OLS) regression. Time series regression is conducted for 1205 sectors over the out-sample period from 31 January 2002 to 31 December 2005. Whilst 1213 sectors are listed as available across the 48 countries in appendix A.4, eight sectors (listed in appendix B.1) are omitted because of insufficient data in the out-sample period. Each regression outputs an F-statistic and associated p-value, an R^2 statistic and an adjusted-R^2 statistic.

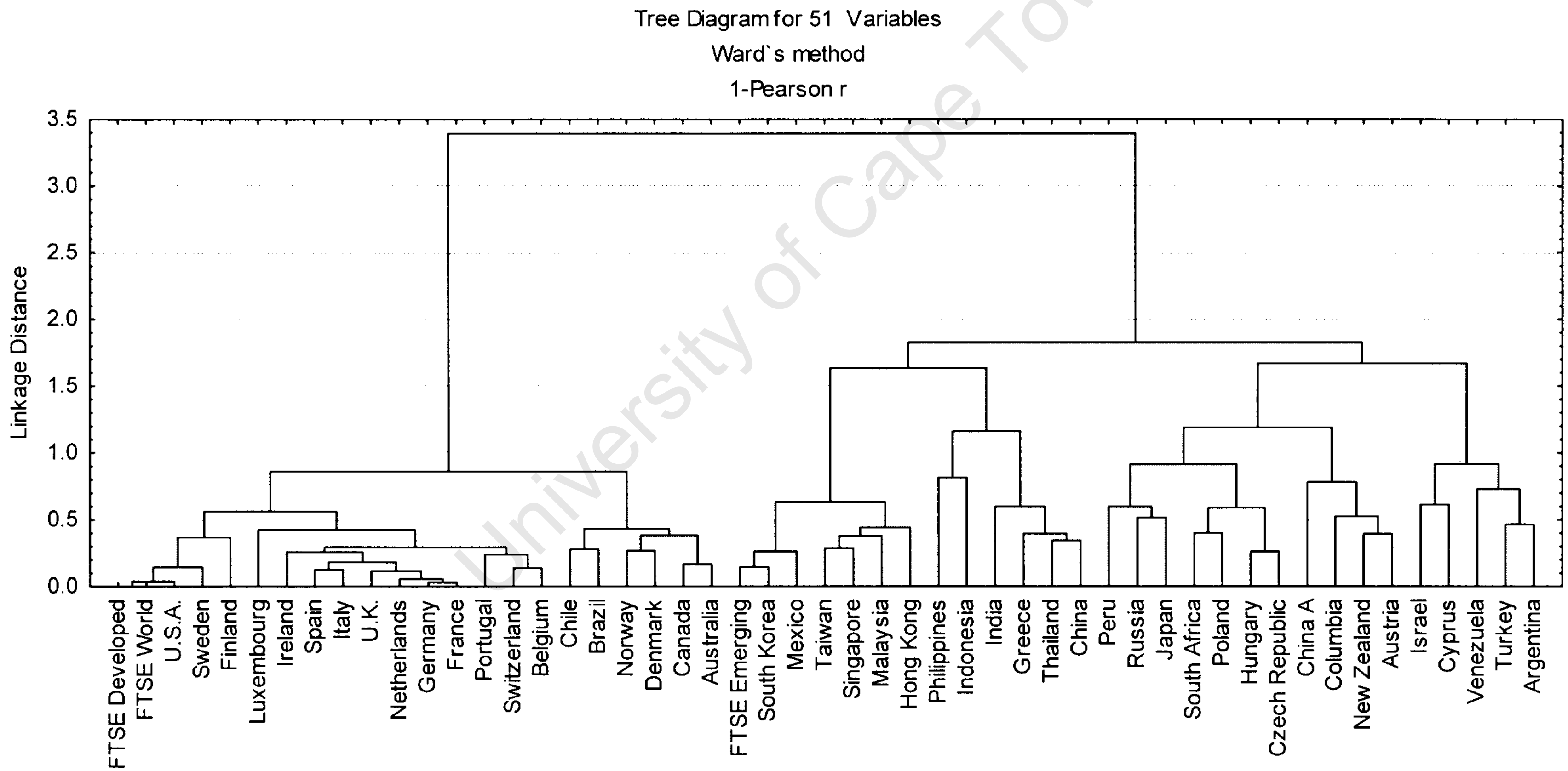
5.3. Empirical Results

5.3.1 Cluster Analysis

The tree diagram in figure 5.3 displays the results of the cluster analysis. The linkage distance, which indicates the degree of dissimilarity between the market indices, is plotted on the vertical axis, whilst the market indices are indicated on the horizontal axis.

Figure 5.3: Cluster Analysis of 51 Market Indices

The tree diagram displays the linkage distances and resultant clusters of the cluster analysis conducted on the times series of monthly returns derived from the 51 market indices (48 countries and three FTSE indices covering the world, developed and emerging markets) over the out-sample period from 31 January 2002 to 31 December 2005.



There appear to be two main clusters, which are formed at linkage distances of approximately 0.85 and 1.80. The first cluster includes all the market indices listed on the horizontal axis from 'FTSE Developed' to 'Australia' and can be broadly classified as the 'developed markets indices'. The second cluster includes all the market indices listed on the horizontal axis from 'FTSE Emerging' to 'Argentina' and can be broadly classified as the 'emerging markets indices'.

There are a few exceptions within each cluster, which do not fit the broad definitions given to them. These exceptions are to be expected since the cluster analysis forms the clusters on the basis of the correlations between the time series of returns across the different market indices, whilst the developed and emerging market classifications prescribed by FTSE International Limited (see appendix B.2) are based on numerous economic criteria. The small linkage distance between the FTSE Developed and FTSE World Market indices can be ascribed to the fact that the indices are market-value-weighted and the developed markets, which have far greater market values than the emerging markets, tend to dominate the index. A further observation in this regard, is that geographical location influences the clustering to an extent: neighbouring markets tend to exhibit a fairly high level of correlation, especially in times of bear markets. For example, the far eastern markets tend to cluster together under the 'emerging markets indices'. Longin and Solnik (2001) show that market indices tend to be highly correlated in bear markets and Kaminsky, Reinhart and Vegh (2003) show the effects of four recent financial crises on neighbouring countries and other emerging markets. The latter show that the devaluation of the Thai Baht in 1997 severely affected Indonesia, Korea, Malaysia and the Philippines and that Russia's defaulting on its domestic bond debt in 1998 had severe effects in all the former Soviet Republics as well as Mexico, Brazil and Hong Kong. The devaluation of the Brazilian Réal in January 1999 is found to have a significant and protracted effect on the Argentinean economy, whilst the devaluation of the Turkish Lira in February 2001 is conjectured to have exacerbated the withdrawal of investors from Argentina. Appendices B.3 and B.4 display the individual tree diagrams for the developed and emerging markets indices, respectively, and exhibit the geographical clustering in more detail.

The cluster analysis also points to the benefits of portfolio diversification into emerging markets. The developed market indices exhibit small clustering distances (all less than 0.85), which indicate a greater level of correlation between the indices than emerging market indices, which exhibit far greater clustering distances (up to 1.80). The implication is that by diversifying from developed into emerging markets, lower correlations can be used to reduce portfolio systematic risk.

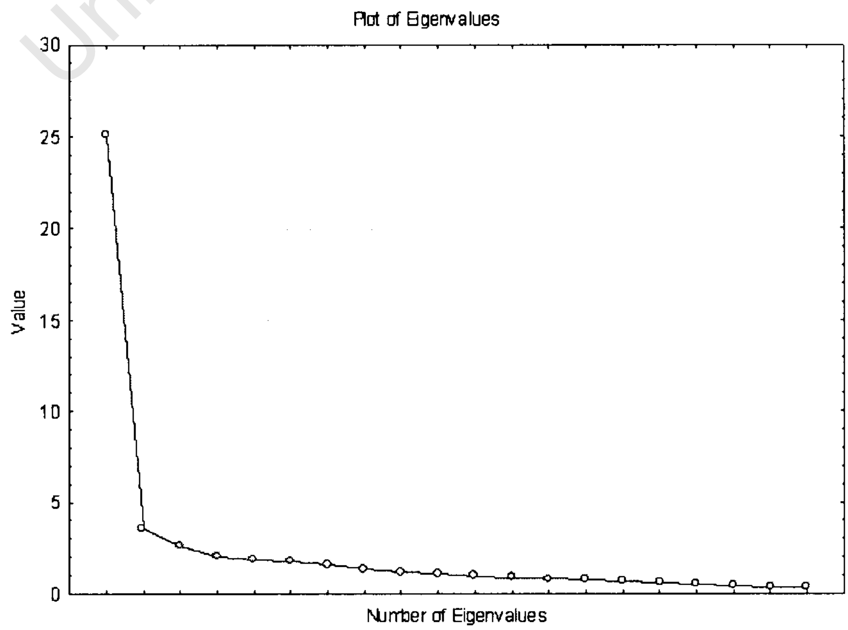
5.3.2 Factor Analysis (using Principal Components)

The factor analysis using the principal components methodology begins with the creation of a Scree plot, which is displayed in figure 5.4. Of the twenty factors plotted, only ten exhibit Eigenvalues greater than one and hence warrant consideration. The Scree plot drops sharply from the first factor to the second factor and drops marginally from the second factor to the third factor. The Scree plot 'flattens out' from the third factor onwards.

The marginal drop from the second to the third factor suggests that the third factor makes little contribution to explaining the variance in the market indices. Consequently, Cattell and Jaspers' (1967) suggestion, that factors be extracted up to the last factor before the Scree plot 'flattens out', is adopted and only two factors are extracted.

Figure 5.4: Scree Plot of Factor Eigenvalues

The Scree plot displays the Eigenvalues of the first twenty factors extracted in the factor analysis using the principal components methodology. The factor analysis is performed using the time series of monthly returns derived from the 51 market indices (48 countries and three FTSE indices covering the world, developed and emerging markets) over the out-sample period from 31 January 2002 to 31 December 2005.

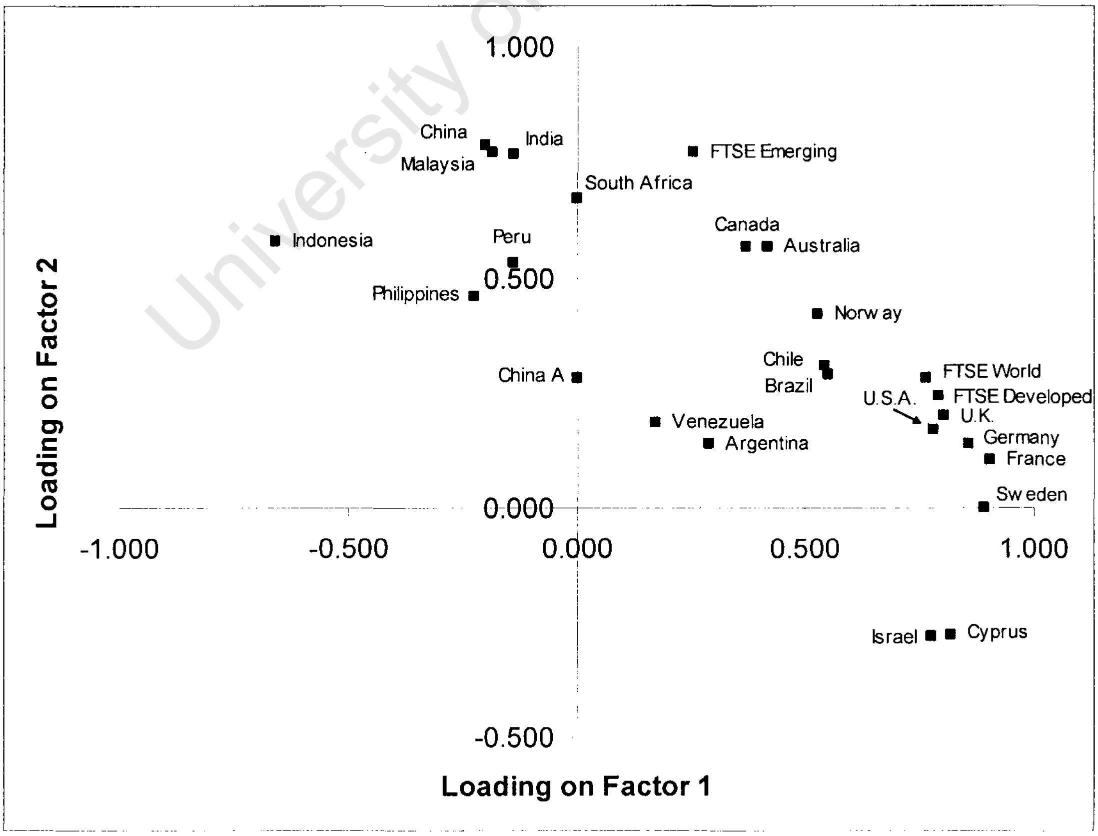


The first factor has an Eigenvalue of 25.05 and hence explains 49.12% of the total variation whilst the second factor has an Eigenvalue of 3.51 and hence explains only 6.88% of the total variation. The factor loadings are rotated so as to redistribute the variance between the two factors and produce more meaningful factor loadings. The un-rotated loadings, the Varimax (raw and normalised) rotated loadings and the Promax rotated loadings are displayed in appendices B.5, B.6 and B.7, respectively.

A scatter plot of the Promax rotated loadings on factors 1 and 2 is displayed in figure 5.5. The scatter plot supports the findings of the cluster analysis in section 5.3.1 in that the developed markets tend to cluster together and the emerging markets tend to cluster together. Furthermore, the influence of geographic location is seen in that distinct Far Eastern, South American and European market clusters can be observed.

Figure 5.5: Scatter Plot of Market Index Loadings on Factors 1 and 2

The scatter plot displays the factor loadings of the 51 market indices (48 countries and three FTSE indices covering the world, developed and emerging markets) on factors 1 and 2. The factor loadings are obtained from the factor analysis conducted on the time series of monthly returns derived from the market indices, and are Promax rotated. Only selected market indices are labelled to avoid clutter. Labelled market indices are indicated by square markers, whilst unlabelled market indices are indicated by diamond-shaped markers. The sample period is the out-sample period from 31 January 2002 to 31 December 2005.



The Promax rotated loadings show that in general, the developed markets tend to load heavily on factor 1, whilst the emerging markets tend to load heavily on factor 2. The FTSE Developed Market index exhibits a significant loading of 0.793 on factor 1 and an insignificant loading of 0.245 on factor 2. Whilst it is not the highest loading index (ten developed countries have higher loadings on factor 1), the FTSE Developed Market index is representative of all the developed countries and more economically interpretable than a single country market index. Similarly, whilst the FTSE Emerging Market index is not the highest loading index on factor 2 (China has a higher loading), it nevertheless has a significant loading of 0.773 on factor 2 and an insignificant loading of 0.256 on factor 1. Consequently, the FTSE Developed Market index and FTSE Emerging Market index are used to proxy for factors 1 and 2, respectively in the Multi-Index model.

The Multi-Index model is thus specified as a two-factor model:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_{i,dev}(r_{dev,t} - r_{f,t}) + \beta_{i,emer}(r_{emer,t} - r_{f,t}) + \varepsilon_{i,t} \tag{5.5}$$

Where $r_{i,t}$ is the observed realised return on sector i at time t

$r_{dev,t}$ is the observed realised return on the FTSE Developed Market index at time t

$r_{emer,t}$ is the observed realised return on the FTSE Emerging Market index at time t

$r_{f,t}$ is the risk-free rate of return at time t

α_i is the excess systematic return on sector i, unaccounted for by the developed and emerging market betas

$\beta_{i,dev}$ is the sensitivity of the excess return on sector i to the excess return on the FTSE Developed Market index

$\beta_{i,emer}$ is the sensitivity of the excess return on sector i to the excess return on the FTSE Emerging Market index

$\varepsilon_{i,t}$ is the unexplained residual return on sector i at time t

5.3.3 Models Tests Results

Table 5.2 displays the summarised results of the time series OLS regressions for the Single-Index, empirical ICAPM and Multi-Index models. 1205 individual sector regressions are performed for each model and hence only the mean F-statistic and associated mean p-value, the percentage of significant regressions (at the 5% level of significance), the mean R^2 statistic and the mean adjusted-R^2 statistic are displayed.

The F-statistic tests the null hypothesis that all the coefficient terms (excluding the constant) in the regressions are equal to zero. A significant F-statistic thus implies that at least one of the coefficients is significantly different from zero. The p-value associated with the F-statistic is used to determine the significance of the regressions. The R^2 statistic shows the proportion of the variance in the dependent variable, which is explained by the independent variables. The R^2 statistic tends to increase when there are many independent variables, despite the fact that the explanatory power of the model may not be increasing. Consequently, the adjusted-R^2 statistic penalises the R^2 statistic when independent variables are added to the regression, which do not contribute to the explanatory power.

Table 5.2: Single-Index, Empirical ICAPM and Multi-Index Model Tests Results

The table shows the mean F-statistic and associated mean p-value, the percentage of significant regressions (at the 5% level of significance), the mean R^2 statistic and the mean adjusted-R^2 statistic. 1205 time series regressions are performed for each of the three models as specified in section 5.2. The sample period is the out-sample period from 31 January 2002 to 31 December 2005.

Regression	Mean F-Statistic	Mean p-Value	Percentage of Significant Regressions	Mean R^2	Mean Adjusted-R^2
Single-Index Model	18.877	0.095	72.78%	0.232	0.212
Empirical ICAPM	7.074	0.090	70.21%	0.327	0.255
Multi-Index Model	10.880	0.093	73.44%	0.272	0.234

The mean F-statistic of the regression tests on the Single-Index model, indicates that the model is weakly significant (at the 10% level). However, 72.78% of the regressions are significant (at the 5% level) indicating that the mean F-statistic and mean p-value may be biased because of a few strongly insignificant regressions. The mean adjusted-R^2 statistic indicates that on average, the world market excess return explains 21.2% of the variation in the individual global sector excess returns.

The empirical ICAPM is on average, marginally more significant than the Single-Index model but still not significant (at the 5% level). However, biases incurred by highly insignificant regressions are again suspected with 70.21% of the regressions exhibiting significance (at the 5% level). On average, the world market excess return and returns on the major currencies versus the US Dollar (see section 5.2.4.2) explain

25.5% of the variation in the individual global sector excess returns, according to the mean adjusted-R^2 statistic.

The Multi-Index model is also weakly significant (at the 10% level) with a mean p-value lying between those of the Single-Index and Multi-Index models. However, with 73.44% of the regressions being significant, it produces the greatest percentage of significant regressions (at the 5% level). The mean adjusted-R^2 statistic indicates that on average, the developed and emerging market excess returns account for 23.4% of the variation in the individual global sector excess returns.

5.4. Summary and Conclusion

Cluster analysis and factor analysis are used to clarify the structure in the market indices of the 48 countries under consideration and the FTSE World, FTSE Developed and FTSE Emerging Market indices. The market indices are found to cluster into two groups, which can be broadly defined as the 'developed markets indices' and the 'emerging markets indices'. Similarly, the factor analysis reveals that after Promax rotation, the FTSE Developed Market index loads significantly on the first factor (and insignificantly on the second factor), whilst the FTSE Emerging Markets index loads significantly on the second factor (and insignificantly on the first factor).

The Single-Index model uses the FTSE World Market index to proxy for the theoretical market portfolio and empirically tests the CAPM. The empirical ICAPM extends the Single-Index model and includes three currency risk premia empirically testing the ICAPM. The Multi-Index model uses the FTSE Developed Market index and the FTSE Emerging Market index to proxy for the factors extracted in the factor analysis and empirically test the two-factor APT model. All three models are found to be marginally significant (mean p-values between 5% and 10%) and yet in each case, more than 70% of the regressions are found to be significant (at the 5% significance level), indicating that some strongly insignificant regressions may be biasing the mean p-values. The empirical ICAPM is the best performing model with the lowest p-value of 0.090 and the highest adjusted-R^2 statistic of 0.255.

The three models are used to risk-adjust the sector returns data used in the attribute tests of the following chapter.

-6-

Univariate Sector-Specific Attribute Analysis

"Through every rift of discovery some seeming anomaly drops out of the darkness, and falls, as a golden link, into the great chain of order."

-Chapin (1814-1880)

6.1. Introduction

This chapter investigates the empirical relationships between monthly sector returns and sector-specific attributes in worldwide markets. Cross-sectional OLS regression tests are run on the unadjusted sector returns and the sector-specific attributes over the in-sample period, from 31 January 1995 to 31 December 2001, and over the out-sample period, from 31 January 2002 to 31 December 2005.

The in-sample tests yield thirteen significant attributes (at the 5% level of significance) in the value, growth and momentum style groups, whilst the out-sample tests yield sixteen significant attributes in the same three style groups. There is the possibility that the results are period-specific and to this end, the two sets of results are compared to check for consistency. The results can be said to be robust to different time periods only if they are found to be significant in both the in and out-sample periods. The cumulative monthly payoffs to the significant out-sample attributes using unadjusted returns data are presented within their style groups.

The monthly sector returns are risk-adjusted in the out-sample period using the Single-Index, empirical ICAPM and Multi-Index models which are constructed and tested in chapter 5. The three sets of risk-adjusted returns are then regressed on the sector-specific attributes over the out-sample period. Risk adjusting the returns allows for inferences to be made regarding the ability of the sector-specific attributes to explain the variation in returns above and beyond that of the asset-pricing models.

Section 6.2 describes the data and methodology, sections 6.3 and 6.4 discuss the unadjusted in-sample and out-sample empirical results, respectively, section 6.5

compares the unadjusted in-sample and out-sample results, section 6.6 discusses the risk-adjusted out-sample empirical results and section 6.7 summarises and concludes.

6.2. Data and Methodology

Ordinary Least Squares (OLS) regression analysis is used to test for significant cross-sectional relationships between monthly sector returns and sector-specific attributes. Tests are conducted on unadjusted returns and risk-adjusted returns, where risk adjustment is conducted using the Single-Index, empirical ICAPM and Multi-Index models of chapter 5. Cross-sectional (i.e. monthly) tests are conducted on the unadjusted returns over the in-sample period from 31 January 1995 to 31 December 2001 and over the out-sample period from 31 January 2002 to 31 December 2005. The same tests are conducted on the risk-adjusted data but only in the out-sample period. 35 sector-specific attributes are tested for the 1213 available sectors summarised in appendix A.4.

Monthly sector returns data is subjected to double winsorisation and then limited to 100% as described in section 4.2.2.1, whilst attribute data is double winsorised and standardised as described in the section 4.2.3.1. Winsorising and limiting the returns data to 100% helps to eliminate outliers in the data, whilst standardising the attribute data allows for direct comparison of the regression coefficients.

6.2.1 Unadjusted Returns

The testing methodology used in this study is line with that employed by Fama and MacBeth (1973) and van Rensburg and Robertson (2003). The cross-sectional regression equation is specified as follows:

$$r_{i,t+1} = \gamma_{0,t+1} + \gamma_{1,t+1} A_t + \varepsilon_{i,t+1} \tag{6.1}$$

Where $r_{i,t+1}$ is the observed realised return on sector i at time $t+1$

A_t is the value of the attribute under consideration at time t

$\gamma_{0,t+1}$ is the cross-sectional OLS regression intercept term at time $t+1$

$\gamma_{1,t+1}$ is the cross-sectional OLS regression coefficient at time $t+1$

$\varepsilon_{i,t+1}$ is the unexplained residual return on sector i at time $t+1$

The sector returns in each month are regressed on the attribute values at the beginning of the same month to ensure that the regression tests are of a predictive rather than descriptive nature.

Cross-sectional regressions are conducted for every month in both the in-sample period from 31 January 1995 to 31 December 2001 and the out-sample period from 31 January 2002 to 31 December 2005. The time series of regression coefficients, which represent the reward or payoff to each attribute in each month, are then recorded. The time series averages are calculated for each attribute in both the in-sample and out-sample periods and are subjected to Student's (1908) t-test (referred to as the 't-test' for the remainder of this chapter). The t-test is used to identify those attributes, which are able to predict monthly sector returns, which are significantly different from zero. The t-statistic is defined as follows:

$$t = \frac{\left(\overline{\gamma}_1 - 0\right)}{\sigma_{\gamma_1} / \sqrt{N}} \tag{6.2}$$

Where $\overline{\gamma}_1$ is the time series average of the cross-sectional regression coefficients for the attribute under consideration

σ_{γ_1} is the time series standard deviation of the cross-sectional regression coefficients for the attribute under consideration

N is the number of observations in the time series

Whilst the t-statistic is able to identify attributes with significant forecasting potential, it does not gauge the accuracy of the forecasts made. Consequently, the Grinold (1989) Information Coefficient (referred to as either the 'Information Coefficient' or 'IC' for the remainder of this chapter) is also calculated for each attribute in the in-sample and out-sample periods, using the time series of returns. The IC is defined as the Pearson correlation (defined in equation 5.1 and referred to as the 'correlation' for the remainder of this chapter) between the expected monthly sector return and the observed realised monthly sector return, notationally:

$$IC = \rho[E(r_{i,t+1}), r_{i,t+1}] \tag{6.3}$$

Which, in a univariate setting is equivalent to:

$$IC = \rho[A_{i,t}, r_{i,t+1}] \tag{6.4}$$

Banz (2004) claims that an IC of 0.1 can be considered to be "quite high" and therefore that the model has predictive power.

The Information Ratio (IR) is also used to test the accuracy of the forecasts but differs to the IC in that it also takes into account the variation across the monthly ICs and thus provides a measure of statistical significance. Several versions of the IR exist but for the purpose of this study, only Qian and Hua's (2004) IR is considered and is calculated as follows:

$$IR = \frac{\overline{IC}}{\sigma(IC)} \tag{6.5}$$

Where $\overline{IC}$ is the mean monthly IC

$\sigma(IC)$ is the standard deviation of the monthly IC

6.2.2 Risk-Adjusted Returns: The Single-Index Model

Cross-sectional regression tests are conducted on monthly Single-Index model risk-adjusted sector returns to test if sector-specific attributes are able to explain the variation in monthly sector returns beyond the ability of the CAPM beta.

The Single-Index model (used in this study as a testable version of the CAPM) allows for observed realised returns to be specified as follows:

$$r_{i,t} = r_{f,t} + \beta_i (r_{m,t} - r_{f,t}) + \xi_{i,t} \tag{6.6}$$

Where $r_{i,t}$ is the observed realised monthly return on sector i at time t

$r_{m,t}$ is the observed realised monthly return on the world market index at time t

$r_{f,t}$ is the monthly risk-free rate of return at time t

β_i is the sensitivity of the excess return on sector i to the excess return on the world market

$\xi_{i,t}$ is the unexplained residual return on sector i at time t

If the CAPM is to hold empirically, then $\xi_{i,t}$ should be a random variable, accounting for any random variation in the monthly sector returns. However, if the CAPM beta does not fully account for the risk of the sector, then $\xi_{i,t}$ will comprise two effects: a systematic effect α_i and random variation $\varepsilon_{i,t}$. Rearranging equation 6.5 and substituting α_i and $\varepsilon_{i,t}$ for $\xi_{i,t}$ leads to the testable form of the Single-Index model presented in equation 5.2:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \varepsilon_{i,t} \tag{6.7}$$

Where the FTSE World Market index is used as a proxy to calculate the monthly return on the world market index, whilst the monthly rate of return on 90-day US treasury bills proxies for the risk-free rate of return. α_i and $\varepsilon_{i,t}$ are the intercept and error terms, respectively after CAPM beta risk adjustment, which together account for all the unexplained variation in the monthly sector returns:

$$(\alpha_i + \varepsilon_{i,t}) = (r_{i,t} - r_{f,t}) - \beta_i(r_{m,t} - r_{f,t}) \tag{6.8}$$

Therefore, the univariate cross-sectional regressions of section 6.2.1 are repeated using, in each case, the unexplained portion of the monthly sector return in place of the total monthly sector return:

$$(\alpha_i + \varepsilon_{i,t+1}) = \gamma_{0,t+1} + \gamma_{1,t+1}A_t + e_{i,t+1} \tag{6.9}$$

Where α_i is the time series regression intercept term from the Single-Index model tests of chapter 5

$\varepsilon_{i,t+1}$ is the residual term from the Single-Index model tests of chapter 5

$e_{i,t+1}$ is the unexplained residual return on sector i at time t+1

The regressions are only conducted on the out-sample data since only this period is subjected to risk adjustment in chapter 5. As in the unadjusted returns tests of section 6.2.1, the independent variables are lagged by one month with respect to the dependent variables to ensure that the tests are of a predictive rather than descriptive nature. The time series averages of the cross-sectional regression coefficients are calculated and subjected to the t-test to identify significant attributes. The mean Information Coefficient and mean Information Ratio are also calculated for each attribute to determine the strength of its forecasting ability.

6.2.3 Risk-Adjusted Returns: The Empirical ICAPM

Cross-sectional regressions are used on monthly data, as in the previous section, to test if sector-specific attributes are able to explain the variation in returns after risk adjustment. However, in this section, returns are risk-adjusted using the ICAPM and hence returns are adjusted for both the ICAPM beta and the sensitivities to the major currencies as described in section 5.2.4.2.

Tests are conducted using the cross-sectional regression testable form of the empirical ICAPM:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \gamma_{i,BD} r_{BD,t} + \gamma_{i,JP} r_{JP,t} + \gamma_{i,UK} r_{UK,t} + \varepsilon_{i,t} \qquad (6.10)$$

Where $r_{i,t}$ is the observed realised monthly return on sector i at time t

$r_{m,t}$ is the observed realised monthly return on the world market index at time t

$r_{n,t}$ is the observed realised monthly return on the currency of country n relative to the US Dollar at time t

$r_{f,t}$ is the monthly risk-free rate of return at time t

α_i is the excess systematic return on sector i, unaccounted for by the risk premia

β_i is the sensitivity of the excess return on sector i to the excess return on the world market

$\gamma_{i,n}$ is the sensitivity of the excess return on sector i to the return on the foreign currency

$\varepsilon_{i,t}$ is the unexplained residual return on sector i at time t

Where, as in the previous section, the FTSE World Market index is used as a proxy for the world market index and the monthly return on US treasury bills proxies for the risk-free rate of return. Similarly, as in the previous chapter, the Datastream country codes for Germany (BD), Japan (JP) and the U.K. (UK) are used to identify the currency returns and sensitivities.

Equation 6.9 is rearranged so as to add the intercept terms to the error terms, which together equal the portion of the total return unaccounted for by the ICAPM:

$$(\alpha_i + \varepsilon_{i,t}) = (r_{i,t} - r_{f,t}) - \beta_i(r_{m,t} - r_{f,t}) - \gamma_{i,BD} r_{BD,t} - \gamma_{i,JP} r_{JP,t} - \gamma_{i,UK} r_{UK,t} \qquad (6.11)$$

The univariate cross-sectional regressions of section 6.2.1 are again repeated using, in each case, the unexplained portion of the monthly sector return in place of the total monthly sector return:

$$(\alpha_i + \varepsilon_{i,t+1}) = \gamma_{0,t+1} + \gamma_{1,t+1} A_t + e_{i,t+1} \qquad (6.12)$$

Where α_i is the time series regression intercept term from the empirical ICAPM tests of chapter 5

$\varepsilon_{i,t+1}$ is the residual term from the empirical CAPM tests of chapter 5

$e_{i,t+1}$ is the unexplained residual return on sector i in month $t+1$

Again, only the out-sample period is tested and the independent variables are lagged with respect to the dependent variables, as in the previous section. The t-test is again used to identify significant attributes and the Information Coefficient and Information Ratio are applied to test forecasting accuracy.

6.2.4 Risk-Adjusted Returns: The Multi-Index Model

In this section the final risk adjustment model is applied to the returns data. Returns are risk-adjusted for the APT model betas by using the testable form of the Multi-Index model. The regression equation is specified as:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_{i,dev}(r_{dev,t} - r_{f,t}) + \beta_{i,emer}(r_{emer,t} - r_{f,t}) + \varepsilon_{i,t} \qquad (6.13)$$

Where $r_{i,t}$ is the observed realised monthly return on sector i at time t

$r_{dev,t}$ is the observed realised monthly return on the FTSE Developed Market index at time t

$r_{emer,t}$ is the observed realised monthly return on the FTSE Emerging Market index at time t

$r_{f,t}$ is the monthly risk-free rate of return at time t

α_i is the excess systematic return on sector i, unaccounted for by the developed and emerging market betas

$\beta_{i,dev}$ is the sensitivity of the excess return on sector i to the excess return on the FTSE Developed Market index

$\beta_{i,emer}$ is the sensitivity of the excess return on sector i to the excess return on the FTSE Emerging Market index

$\varepsilon_{i,t}$ is the unexplained residual return on sector i at time t

Where, as in the previous sections, the monthly return on US treasury bills proxies for the risk-free rate of return.

Rearranging and combining the intercept and residual terms, as in the previous sections, leads to the following expression for the portion of the total return unaccounted for by the developed and emerging market betas in the APT model:

$$(\alpha_i + \varepsilon_{i,t}) = (r_{i,t} - r_{f,t}) - \beta_{i,dev}(r_{dev,t} - r_{f,t}) - \beta_{i,emer}(r_{emer,t} - r_{f,t}) \tag{6.14}$$

The univariate cross-sectional regressions of section 6.2.1 are once again repeated using the unexplained portion of the monthly sector return in place of the total monthly sector return:

$$(\alpha_i + \varepsilon_{i,t+1}) = \gamma_{0,t+1} + \gamma_{1,t+1} A_t + e_{i,t+1} \tag{6.15}$$

Where α_i is the time series regression intercept term from the Multi-Index model tests of chapter 5

$\varepsilon_{i,t+1}$ is the residual term from the Multi-Index model tests of chapter 5

$e_{i,t+1}$ is the unexplained residual return on sector i at time $t+1$

Once again, only the out-sample period is considered, independent variables are lagged with respect to the dependent variables and the attributes are tested for significance with the t-test and for forecasting accuracy with the Information Coefficient and Information Ratio.

It is noted at this point that since the risk-adjusting betas and gammas of the CAPM, ICAPM and APT model are derived from the same out-sample data which is used in the above attribute testing, all the above regression tests will be biased against the discovery of significant attributes. Therefore, this bias accentuates the importance of any significant attributes that may be found.

6.2.5 Identification of Highly Correlated Attributes

The 35 attributes, under consideration in this study, were chosen or constructed so as to create a comprehensive list for testing. Consequently, it is to be expected that some of the attribute payoffs will exhibit a degree of similarity and may even be highly correlated. Correlation matrices are used to identify pairs of highly correlated attributes. Correlation coefficients are calculated for every pair of significant attributes in the in-sample and out-sample periods using both the unadjusted and risk-adjusted time series of payoffs to the respective attributes. In this analysis a pair of attributes, which has a 'high degree of correlation' is defined as having a correlation coefficient greater than 0.7 or less than –0.7. Whilst no attributes are excluded for high correlation, they are highlighted in the correlation matrices displayed in appendices C.10 to C.14.

6.3. Empirical Results: Unadjusted Returns (In-Sample)

6.3.1 Cross-Sectional Regression Results

The univariate cross-sectional OLS regression results obtained when regressing the unadjusted returns on the various sector-specific attributes over the in-sample period are shown in table 6.1. The t-statistic, mean regression coefficient, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given and the results are sorted in descending order according to the absolute values of the t-statistics. Thirteen attributes were found to be significant in the in-sample cross-sectional regression tests.

Table 6.1: In-Sample Cross-Sectional Regression Results using Unadjusted Data

The table shows the results of the univariate cross-sectional regression analyses for the unadjusted returns against each sector-specific attribute over the in-sample period from 31 January 1995 to 31 December 2001. The mean regression coefficient, t-statistic, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given for each attribute. The attributes are sorted in descending order according to the absolute values of the t-statistics. Attributes which are significant at the 5% level of significance (two-tailed) have their t-statistics displayed in bold. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

Attribute	Mean Coefficient	T-Statistic	Mean Information Coefficient	Mean Information Ratio	Number of Observations in Final Month
MOM-12	0.0061	**3.7272**	0.0696	0.4674	1116
DY	0.0029	**3.5749**	0.0357	0.4571	1120
C-12P	0.0025	**3.4618**	0.0303	0.4326	883
MOM-6	0.0058	**3.3814**	0.0626	0.4147	1111
C-6P	0.0022	**3.2834**	0.0244	0.3829	914
PO	0.0016	**2.6498**	0.0178	0.2940	1100
CB	0.0019	**2.5450**	0.0222	0.3103	894
MOM-3	0.0038	**2.4512**	0.0379	0.2780	1107
CP	0.0021	**2.4219**	0.0245	0.2870	930
D-12P	0.0017	**2.3849**	0.0241	0.3625	1100
ROE	0.0016	**2.3776**	0.0206	0.3219	938
MOM-1	0.0028	**2.2725**	0.0286	0.2494	1110
D-24P	0.0017	**2.2488**	0.0237	0.3531	1040
MVTMV-24	0.0016	1.9627	0.0163	0.2020	72
SIGMA	-0.0036	-1.9544	-0.0456	-0.2799	1142
C-24P	0.0014	1.9010	0.0207	0.2848	829
MVTMV-3	0.0011	1.7852	0.0113	0.1754	410
EY	0.0017	1.7443	0.0232	0.2534	1004
VO-12	0.0011	1.7187	0.0122	0.1891	388
VO-6	0.0013	1.6218	0.0117	0.1670	418
DC	0.0011	1.5692	0.0144	0.1891	965
VO-24	0.0012	1.5572	0.0121	0.1542	72
MVTMV-6	0.0012	1.5404	0.0115	0.1604	415
LNMV	0.0014	1.5324	0.0155	0.1616	1142
VO-3	0.0009	1.4334	0.0094	0.1438	409
MVTMV-1	0.0010	1.3776	0.0109	0.1532	402
VO-1	0.0010	1.3637	0.0105	0.1499	402
MOM-18	0.0020	1.2872	0.0281	0.1931	1089
D-6P	0.0008	1.2728	0.0112	0.1716	1088
E-6P	0.0009	1.2146	0.0110	0.1598	982
MVTMV-12	0.0007	1.1632	0.0088	0.1419	385
E-24P	0.0004	0.5801	0.0087	0.1233	907
E-12P	0.0004	0.5114	0.0082	0.1046	951
MVTMV	-0.0003	-0.4070	-0.0042	-0.0584	426
BP	0.0003	0.2729	0.0038	0.0378	1000

Appendix C.4 gives more detailed results for the unadjusted returns regressions over the in-sample period: the mean yearly coefficients and their associated t-statistics are displayed for each attribute, grouped according to style.

6.3.2 Cumulative Monthly Payoffs to Attributes

Cumulative monthly payoffs are calculated for all the significant sector-specific attributes to illustrate their relative abilities to create wealth. The attributes are grouped according to style for illustrative and comparative purposes. The 'value', 'growth' and 'momentum' style groups all possess significant attributes and are discussed below.

It should be noted that the cumulative payoffs represent those to an equally-weighted portfolio and not a market-weighted portfolio, since the sector returns are not weighted by market capitalisation.

The 'size and liquidity' style group does not possess any significant attributes, which is surprising because of the well documented size effect: Banz (1981), Reinganum (1981), Basu (1983), Chan and Chen (1991) and Fama and French (1992) all identify a small-firm size effect. Brown, Kleidon and Marsh (1983), whilst identifying a size effect, also find that it is not stable over time. They are supported by Dimson and Marsh (1999), Gustafson and Miller (1999) and Chan, Karceski and Lakonishok (2000) who all confirm a reversal in the effect over a more contemporaneous period. It is suggested that the effect is time-period specific and that either the effect has disappeared or reversed at some point in this study, masking its significance.

The 'risk' style group which comprises only 12-month prior return volatility (SIGMA) is also insignificant. This finding is in stark contrast to the widely accepted risk-return framework originally presented by Markowitz (1952). According to theory, there should be a significant negative relationship between the sector returns and the risk measure (SIGMA in this case).

6.3.2.1. Value

Cash earnings per share to price (CP) and dividend yield (DY) are the only significant attributes in the 'value' style group. Both CP and DY pay off positively over the in-sample period, with cumulative payoffs of 19.29% and 26.85%, respectively. The evolution of the cumulative payoffs to these two attributes are displayed in appendix C.6.1. Interestingly, the payoffs are fairly insubstantial over the period from 31 January 1995 to 31 January 2000, but increase rapidly from 31 January 2000 to 31 December 2001. These findings are supported by Litzenberger and Ramaswamy

(1979), Blume (1980), Keim (1985) and Fama and French (1988b), all of whom find significant dividend yield effects.

Surprisingly, neither book value per share to price (BP) nor earnings yield (EY) is found to be significant. The latter yields a p-value of 0.085 and thus may be regarded as weakly significant, whilst the former has a p-value of 0.786, indicating a strongly insignificant result. These results contrast the literature with Fama and French (1992) documenting a significant book-to-market value effect and Basu (1977, 1983), Ball (1978) and Reinganum (1981) documenting significant earnings-to-price effects. The absence of such effects in this study could be the result of the inherent averaging across the different markets i.e. effects could exist in some markets but are rendered insignificant in combination with other markets. Michaud (1999) shows that the significance of factors varies between markets and that whilst several factors are generally significant, they tend to be different factors.

6.3.2.2. Growth

Seven significant attributes pay off positively within the 'growth' style group over the in-sample period. They all display a slight 'hump' from January 1998 to January 1999, but otherwise grow consistently over the period. Appendix C.6.2 displays the evolution of the cumulative payoffs and table 6.2 shows the cumulative payoffs for each attribute as at the end of the in-sample period.

Table 6.2: In-Sample Cumulative Payoffs to Growth Style Attributes

The table shows the cumulative payoffs to the significant sector-specific attributes, which fall in the 'growth' style group, as at the end of the in-sample period: 31 December 2001. All seven attributes are significant at the 5% level over the in-sample period, from 31 January 1995 to 31 December 2001, in the cross-sectional OLS regression tests on the unadjusted returns data. The attributes are displayed in descending order of cumulative payoff. All data was obtained from Datastream International at the University of Cape Town.

Code	Characteristic	Cumulative Payoff
C-12P	12-month growth in Cash Earnings, to Price	23.24%
C-6P	6-month growth in Cash Earnings, to Price	19.64%
CB	Cash Earnings to Book Value	17.14%
D-12P	12-month growth in Dividends, to Price	15.51%
D-24P	24-month growth in Dividends, to Price	14.64%
PO	Payout Ratio	14.03%
ROE	Return on Equity	13.95%

6.3.2.3. Momentum

One, three, six and twelve-month prior return (MOM-1, MOM-3, MOM-6 & MOM-12) all have significant positive payoffs over the in-sample period. MOM-12 produces the greatest payoffs but is closely followed by MOM-6. All the significant momentum attributes pay off fairly consistently over the period, but there is an increase in volatility towards the end, which seems to be compensated for by higher returns. Despite the contravention of weak-form market efficiency, momentum seems to be powerful predictor of equity returns. Jegadeesh and Titman (1993) observe similar results when constructing 'winner' and 'loser' portfolios based on the performance of the past six months and then holding the portfolios for six months.

The cumulative payoffs to each momentum attribute at the end of the in-sample period are displayed in table 6.3, whilst the evolution of the cumulative payoffs over the period is shown in appendix C.6.3.

Table 6.3: In-Sample Cumulative Payoffs to Momentum Style Attributes

The table shows the cumulative payoffs to the significant sector-specific attributes, which fall in the 'momentum' style group, as at the end of the in-sample period: 31 December 2001. All four attributes are significant at the 5% level over the in-sample period, from 31 January 1995 to 31 December 2001, in the cross-sectional OLS regression tests on the unadjusted returns data. The attributes are displayed in descending order of cumulative payoff. All data was obtained from Datastream International at the University of Cape Town.

Code	Characteristic	Cumulative Payoff
MOM-12	12-month prior return	64.66%
MOM-6	6-month prior return	60.57%
MOM-3	3-month prior return	35.91%
MOM-1	1-month prior return	26.08%

6.4. Empirical Results: Unadjusted Returns (Out-Sample)

6.4.1 Cross-Sectional Regression Results

The results of the cross-sectional OLS regression tests for the unadjusted returns against each sector-specific attribute over the out-sample period are displayed in table 6.4. As for the in-sample results, the t-statistic, mean regression coefficient, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given in all cases, and the results are sorted in descending according of the absolute values of the t-statistics. Sixteen attributes were found to be significant in the unadjusted returns regression tests over the out-sample period.

Table 6.4: Out-Sample Cross-Sectional Regression Results using Unadjusted Data

The table shows the results of the univariate cross-sectional regression analyses for the unadjusted returns against each sector-specific attribute over the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient, t-statistic, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given for each attribute. The attributes are sorted in descending order according to the absolute values of the t-statistics. Attributes which are significant at the 5% level of significance (two-tailed) have their t-statistics displayed in bold. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

Attribute	Mean Coefficient	T-Statistic	Mean Information Coefficient	Mean Information Ratio	Number of Observations in Final Month
C-12P	0.0032	**6.8925**	0.0467	0.9438	979
CP	0.0041	**5.8601**	0.0594	0.8798	997
C-24P	0.0038	**5.6779**	0.0575	0.8461	955
EY	0.0039	**5.5735**	0.0543	0.8208	1103
BP	0.0036	**5.1263**	0.0500	0.7093	1067
DY	0.0032	**4.6865**	0.0448	0.6640	1173
D-12P	0.0018	**3.5264**	0.0286	0.5735	1152
D-24P	0.0021	**3.3675**	0.0332	0.5553	1123
E-12P	0.0021	**3.1505**	0.0308	0.4682	1070
CB	0.0015	**2.9379**	0.0222	0.4424	960
E-24P	0.0021	**2.8069**	0.0330	0.4541	1020
MOM-12	0.0040	**2.7260**	0.0602	0.4683	1147
MOM-18	0.0038	**2.5816**	0.0575	0.4520	1140
PO	0.0011	**2.3973**	0.0158	0.3463	1169
E-6P	0.0014	**2.3860**	0.0202	0.3391	1089
C-6P	0.0012	**2.3003**	0.0177	0.3387	983
D-6P	0.0008	1.6494	0.0117	0.2624	1165
MOM-6	0.0022	1.6287	0.0343	0.2853	1174
ROE	0.0008	1.2903	0.0119	0.1984	1014
MVTMV-24	0.0007	1.2785	0.0102	0.2000	620
MOM-3	0.0013	1.0601	0.0195	0.1785	1163
LNMV	-0.0010	-1.0231	-0.0104	-0.1075	1201
MVTMV-1	0.0006	1.0124	0.0085	0.1529	930
MVTMV	0.0066	0.9418	-0.0021	-0.0292	960
MVTMV-12	0.0004	0.9330	0.0094	0.2193	573
MVTMV-6	0.0004	0.9260	0.0064	0.1392	915
MVTMV-3	0.0005	0.8240	0.0066	0.1237	929
SIGMA	0.0014	0.7471	0.0199	0.1276	1204
VO-6	0.0003	0.6928	0.0050	0.1030	913
VO-12	0.0003	0.6630	0.0052	0.1254	573
MOM-1	0.0004	0.3197	0.0067	0.0616	1179
VO-24	-0.0001	-0.2521	-0.0017	-0.0336	619
DC	0.0001	0.1547	0.0023	0.0405	1058
VO-1	0.0001	0.1062	0.0011	0.0189	928
VO-3	0.0000	-0.0200	-0.0015	-0.0269	927

Appendix C.4 gives more detailed results for the unadjusted returns regressions over the out-sample period: the mean yearly coefficients and their associated t-statistics are displayed for each attribute, grouped according to style.

6.4.2 Cumulative Monthly Payoffs

As for the in-sample results, cumulative monthly payoffs are calculated for all the significant sector-specific attributes in the out-sample period. The cumulative monthly payoffs illustrate the relative abilities of the attributes to create wealth. The attributes are grouped according to style for illustrative and comparative purposes.

Once again, the cumulative payoffs represent those to an equally-weighted portfolio and not a market-weighted portfolio, since the sector returns are not weighted by market capitalisation.

The 'value', 'growth' and 'momentum' style groups are again found to possess significant attributes, although some of the attributes are not consistent between the two periods. The 'size and liquidity' and 'risk' style groups do not possess any significant attributes. Insignificant size and liquidity style effects are surprising because of the well documented size effect and the widely accepted risk-return framework (discussed in section 6.3.3).

6.4.2.1. Value

The complete 'value' style group comprises book value per share to price (BP), cash earnings per share to price (CP), dividend yield (DY) and earnings yield (EY), all of which are significant in the out-sample unadjusted returns regression tests. They all pay off positively over the out-sample period as illustrated in figure 6.1, and the final cumulative payoffs at the end of the out-sample period are given in table 6.5.

The cumulative payoffs in the value style group tend to evolve fairly consistently over the out-sample period. The out-sample results thus contrast the in-sample results in two ways: firstly, all four attributes are significant in the out-sample period whereas only two are significant in the in-sample period and secondly, the cumulative payoffs evolve consistently in the out-sample period as opposed to remaining almost flat for a considerable proportion of the sample and then increasing rapidly, as in the in-sample period. The implication is that the results tend to exhibit a degree of sample specificity and may not be robust across different time periods.

Figure 6.1: Out-Sample Cumulative Monthly Payoffs to Value Style Attributes

The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'value' style group. The attributes are book value per share to price (BP), cash earnings per share to price (CP), dividend yield (DY) and earnings yield (EY), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the unadjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.

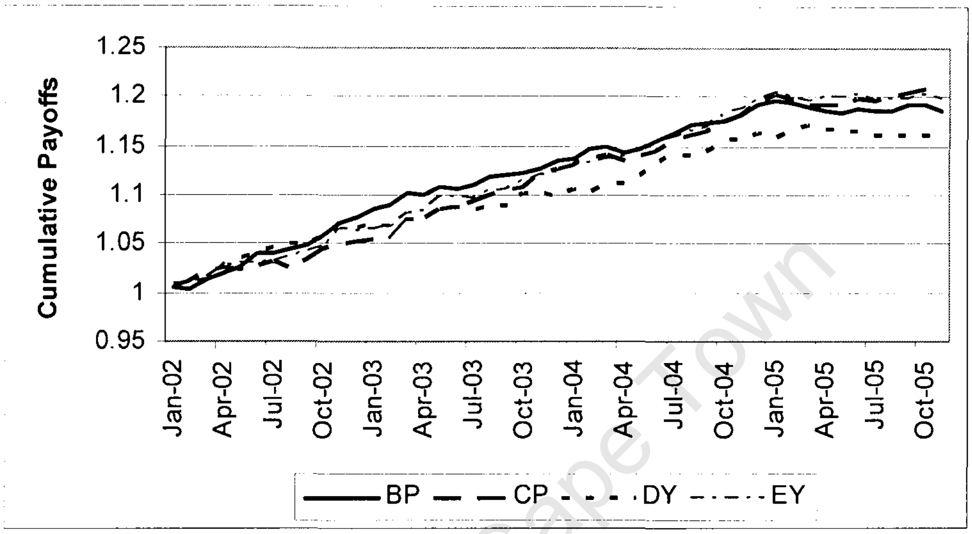


Table 6.5: Out-Sample Cumulative Payoffs to Value Style Attributes

The table shows the cumulative payoffs to the significant sector-specific attributes, which fall in the 'value' style group, as at the end of the out-sample period: 31 December 2005. All four attributes are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the unadjusted returns data. The attributes are displayed in descending order of cumulative payoff. All data was obtained from Datastream International at the University of Cape Town.

Code	Characteristic	Cumulative Payoff
CP	Cash Earnings per Share to Price	20.94%
EY	Earnings Yield	19.89%
BP	Book Value per Share to Price	18.54%
DY	Dividend Yield	16.04%

6.4.2.2. Growth

Ten significant attributes pay off positively within the 'growth' style group over the out-sample period in the unadjusted returns regression tests. They all tend to grow consistently over the period but some tend to pay off considerably more than others (contrast C-24P and C-6P). Figure 6.2 displays the evolution of the cumulative payoffs and table 6.6 shows the cumulative payoffs for each attribute as at the end of the out-sample period.

Whilst the growth style group is fairly consistent between the in and out-sample periods in terms of the 6 and 12-month growth in cash earnings, to price ratios (C-6P & C-12P), the cash earnings to book value ratio (CB), the 12 and 24-month growth in dividends, to price ratio (D-12P & D-24P) and the payout ratio (PO), it is inconsistent with other ratios. The return on equity (ROE) goes from being significant at the 5% level in the in-sample period, to being insignificant, even at the 10% level, in the out-sample period. The 24-month growth in cash earnings, to price (C-24P) goes from being weakly significant at the 10% level in the in-sample period to being significant in the out-sample period, whilst the 6, 12, and 24-month growth in earnings, to price (E-6P, E-12P & E-24P) become significant at the 5% level in the out-sample period after being insignificant in the in-sample period, even at the 10% level.

Figure 6.2: Out-Sample Cumulative Monthly Payoffs to Growth Style Attributes

The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'growth' style group. The attributes are 6, 12 and 24-month growth in cash earnings, to price (C-6P, C-12P & C-24P), cash earnings to book value (CB), 12 and 24-month growth in dividends, to price (D-12P & D-24P), 6, 12 and 24-month growth in earnings, to price (E-6P, E-12P & E-24P) and the payout ratio (PO), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the unadjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.

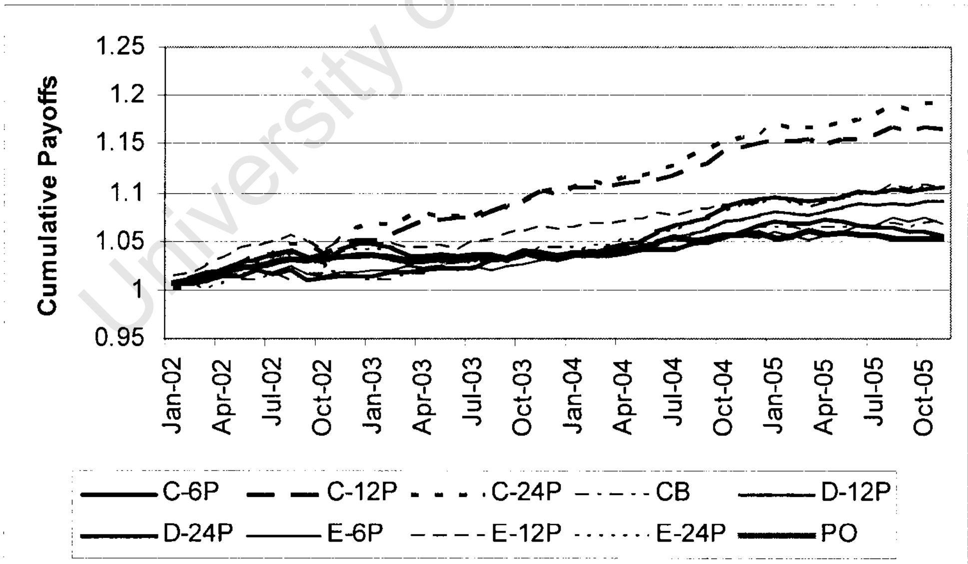


Table 6.6: Out-Sample Cumulative Payoffs to Growth Style Attributes

The table shows the cumulative payoffs to the significant sector-specific attributes, which fall in the 'growth' style group, as at the end of the out-sample period: 31 December 2005. All seven attributes are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the unadjusted returns data. The attributes are displayed in descending order of cumulative payoff. All data was obtained from Datastream International at the University of Cape Town.

Code	Characteristic	Cumulative Payoff
C-24P	24-month growth in Cash Earnings, to Price	19.38%
C-12P	12-month growth in Cash Earnings, to Price	16.44%
E-12P	12-month growth in Earnings, to Price	10.50%
E-24P	24-month growth in Earnings, to Price	10.43%
D-24P	24-month growth in Dividends, to Price	10.42%
D-12P	12-month growth in Dividends, to Price	9.04%
CB	Cash Earnings to Book Value	7.09%
E-6P	6-month growth in Earnings, to Price	6.79%
C-6P	6-month growth in Cash Earnings, to Price	5.55%
PO	Payout Ratio	5.21%

6.5. Comparison of In-Sample and Out-of-Sample Results

In order to evaluate the consistency of the sector-specific attributes using unadjusted returns data between the in and out-sample periods, a comparison of means t-statistic is calculated for each attribute, assuming unequal variances in the two samples. Table 6.7 displays the in and out-sample mean coefficients and associated t-statistics as well as the comparison of means t-statistics. T-statistics that are significant at the 5% level are shown in bold and the attributes are sorted according to the absolute value of the t-statistics in the in-sample period and displayed in descending order.

Table 6.7: Comparison of In-Sample and Out-Sample Results

The table shows the mean monthly coefficients and associated t-statistics for all the sector-specific attributes from the OLS cross-sectional regression tests. Results are displayed for both the in-sample period, from 31 January 1995 to 31 December 2001, and out-sample period, from 31 January 2002 to 31 December 2005. Comparison of means t-statistics (assuming unequal variances) between the in-sample and out-sample coefficients are displayed for all the attributes. Mean coefficients which are significantly different at the 5% level over the in and out-sample periods are displayed in bold font. The characteristics are displayed in descending order of absolute value of their t-statistics in the in-sample period and all significant t-statistics are presented in bold font. All data was obtained from Datastream International at the University of Cape Town.

Attribute	In-Sample		Out-Sample		Comparison of Means T-Statistic
	Mean Coefficient	T-Statistic	Mean Coefficient	T-Statistic	
MOM-12	0.0061	**3.7272**	0.0040	**2.7260**	0.9397
DY	0.0029	**3.5749**	0.0032	**4.6865**	-0.3032
C-12P	0.0025	**3.4618**	0.0032	**6.8925**	-0.8506
MOM-6	0.0058	**3.3814**	0.0022	1.6287	1.6313
C-6P	0.0022	**3.2834**	0.0012	**2.3003**	1.2084
PO	0.0016	**2.6498**	0.0011	**2.3973**	0.6590
CB	0.0019	**2.5450**	0.0015	**2.9379**	0.4933
MOM-3	0.0038	**2.4512**	0.0013	1.0601	1.2345
CP	0.0021	**2.4219**	0.0041	**5.8601**	-1.7212
D-12P	0.0017	**2.3849**	0.0018	**3.5264**	-0.1223
ROE	0.0016	**2.3776**	0.0008	1.2903	0.9019
MOM-1	0.0028	**2.2725**	0.0004	0.3197	1.3978
D-24P	0.0017	**2.2488**	0.0021	**3.3675**	-0.4858
MVTMV-24	0.0016	1.9627	0.0007	1.2785	0.8810
SIGMA	-0.0036	-1.9544	0.0014	0.7471	-1.9227
C-24P	0.0014	1.9010	0.0038	**5.6779**	**-2.3933**
MVTMV-3	0.0011	1.7852	0.0005	0.8240	0.7744
EY	0.0017	1.7443	0.0039	**5.5735**	-1.8232
VO-12	0.0011	1.7187	0.0003	0.6630	1.0496
VO-6	0.0013	1.6218	0.0003	0.6928	1.0061
DC	0.0011	1.5692	0.0001	0.1547	1.1462
VO-24	0.0012	1.5572	-0.0001	-0.2521	1.4333
MVTMV-6	0.0012	1.5404	0.0004	0.9260	0.8392
LNMV	0.0014	1.5324	-0.0010	-1.0231	1.8047
VO-3	0.0009	1.4334	0.0000	-0.0200	1.0897
MVTMV-1	0.0010	1.3776	0.0006	1.0124	0.4381
VO-1	0.0010	1.3637	0.0001	0.1062	0.9453
MOM-18	0.0020	1.2872	0.0038	**2.5816**	-0.8136
D-6P	0.0008	1.2728	0.0008	1.6494	0.0761
E-6P	0.0009	1.2146	0.0014	**2.3860**	-0.6000
MVTMV-12	0.0007	1.1632	0.0004	0.9330	0.3416
E-24P	0.0004	0.5801	0.0021	**2.8069**	-1.5667
E-12P	0.0004	0.5114	0.0021	**3.1505**	-1.5583
MVTMV	-0.0003	-0.4070	0.0066	0.9418	-0.9840
BP	0.0003	0.2729	0.0036	**5.1263**	**-2.5312**

Of the thirteen attributes which are found to be significant in the in-sample period, nine are also found to be significant in the out-sample period. Dividend yield (DY), 6 and 12-month growth in cash earnings, to price (C-6P & C-12P), the payout ratio (PO), cash earnings to book value (CB), cash earnings per share to price (CP) and 12 and 24-month growth in dividends, to price (D-12P & D-24P) and 12-month prior return (MOM-12) are all significant in both sample periods, which indicates that they are potentially more robust than those attributes which are significant in only one period.

The comparison of means t-statistic is used to identify attributes which produces significantly different payoffs in the two sample periods. Only two attributes are shown to perform significantly differently: 24-month growth in cash earnings, to price (C-24P) and book value per share to price (BP), both of which produce significant payoffs in the out-sample period but not in the in-sample period. It is conjectured that BP may display significant positive payoffs in the out-sample period, which coincides with the post 'I.T. bubble' era, because lower stock prices pushed up BP figures thereby providing a better reflection of total sector returns. In conclusion, whilst C-24P and BP seem to produce sample-specific results, the rest of the attributes are more robust to varying time periods.

6.6. Empirical Results: Risk-Adjusted Returns (Out-Sample)

The univariate cross-sectional OLS regression results obtained when regressing the risk-adjusted returns on the various sector-specific attributes over the out-sample period are shown in table 6.8. The t-statistics and mean regression coefficients are given for each attribute after risk adjustment of the returns with the Single-Index, empirical ICAPM and Multi-Index models. The results are sorted in descending order of the absolute values of the t-statistics under Single-Index model risk adjustment. The risk-adjustment procedures, using the three different models, are laid out in sections 6.2.2, 6.2.3 and 6.2.4, respectively. More in-depth tables of results are given for the three models in appendices C.1 to C.3; as well as t-statistics and mean coefficients, the tables also include mean Information Coefficients, mean Information Ratios and the number of observations in the final month.

Table 6.8: Out-Sample Cross-Sectional Regression Results using Risk-Adjusted Data

The table shows the results of the univariate cross-sectional regression analyses for the risk-adjusted returns against each sector-specific attribute over the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient and t-statistic are given for each attribute and for each model used in risk-adjusting the data: the Single-Index, empirical ICAPM and Multi-Index models. The attributes are sorted in descending order according to the absolute values of the t-statistics under Single Index model risk adjustment. Attributes which are significant at the 5% level of significance (two-tailed) have their t-statistics displayed in bold. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

	Single-Index Model Adjusted		Empirical ICAPM Adjusted		Multi-Index Model Adjusted	
Attribute	Mean Coefficient	T-Statistic	Mean Coefficient	T-Statistic	Mean Coefficient	T-Statistic
C-12P	0.0026	**7.7660**	0.0023	**7.8672**	0.0023	**6.6078**
CP	0.0030	**7.6720**	0.0030	**7.8370**	0.0022	**5.6739**
C-24P	0.0030	**7.4312**	0.0024	**6.6765**	0.0027	**6.2649**
EY	0.0033	**6.9550**	0.0028	**6.7340**	0.0027	**5.4535**
BP	0.0032	**6.5478**	0.0029	**6.2855**	0.0025	**4.9312**
DY	0.0032	**5.5054**	0.0028	**5.6061**	0.0032	**5.6161**
MOM-18	0.0042	**5.1464**	0.0036	**4.7858**	0.0036	**4.5584**
D-24P	0.0025	**5.1396**	0.0021	**5.0105**	0.0022	**4.6471**
D-12P	0.0019	**4.8035**	0.0016	**4.2038**	0.0017	**4.1547**
MOM-12	0.0037	**4.4493**	0.0033	**4.3284**	0.0034	**4.3716**
C-6P	0.0015	**4.1032**	0.0013	**3.2123**	0.0013	**3.7207**
PO	0.0017	**4.0483**	0.0014	**4.0799**	0.0019	**4.7184**
E-24P	0.0018	**3.7418**	0.0013	**3.2221**	0.0013	**2.8966**
CB	0.0010	**3.4211**	0.0011	**3.8159**	0.0010	**3.3300**
E-12P	0.0015	**3.1250**	0.0010	**2.1983**	0.0012	**2.5504**
E-6P	0.0012	**2.9236**	0.0010	**2.5591**	0.0007	1.7431
D-6P	0.0010	**2.6708**	0.0009	**2.3414**	0.0007	**2.0285**
MVTMV-24	0.0012	**2.6677**	0.0011	**2.7020**	0.0010	**2.5932**
VO-12	0.0010	**2.4958**	0.0006	1.7459	0.0008	**2.0644**
MVTMV-12	0.0009	**2.4250**	0.0006	1.5695	0.0009	**2.7499**
LNMV	-0.0014	**-2.2901**	-0.0007	-1.3676	-0.0019	**-3.4079**
ROE	0.0009	1.9299	0.0006	1.3712	0.0009	**2.1085**
MOM-6	0.0014	1.9048	0.0014	**2.0704**	0.0012	1.6003
DC	0.0009	1.8628	0.0007	1.7163	0.0012	**2.5159**
MVTMV-3	0.0006	1.5298	0.0003	0.8830	0.0003	0.6416
SIGMA	-0.0012	-1.3313	-0.0002	-0.2668	-0.0027	**-3.2329**
MOM-3	0.0010	1.2666	0.0007	1.0128	0.0011	1.5610
MOM-1	0.0008	1.1283	0.0008	1.1263	0.0004	0.5784
VO-24	0.0005	0.8735	0.0005	0.9054	0.0002	0.3254
MVTMV-1	0.0003	0.6921	0.0002	0.4881	0.0004	1.0858
MVTMV	-0.0003	-0.6267	-0.0002	-0.3594	-0.0008	-1.5077
VO-3	0.0002	0.4286	0.0000	-0.0582	-0.0001	-0.2286
MVTMV-6	0.0001	0.3523	0.0001	0.3309	0.0001	0.4236
VO-6	0.0001	0.3309	0.0000	0.1086	0.0001	0.3909
VO-1	0.0000	0.0343	-0.0001	-0.1380	0.0001	0.2651

Appendix C.5 gives more detailed results for the risk-adjusted returns regressions over the out-sample period: the mean yearly coefficients and their associated t-statistics are displayed for each attribute, grouped according to style and for each risk-adjustment model.

Twenty-one, nineteen and twenty-three attributes are found to be significant in the Single-Index model, empirical ICAPM and Multi-Index model risk-adjusted returns regression tests, respectively. The results are surprising in that if the risk-adjustment models are working effectively, then there should be fewer significant attributes after risk adjustment, not more. Furthermore, of the sixteen significant out-sample attributes found using the unadjusted returns, only one, 6-month growth in earnings, to price (E-6P) is insignificant after risk adjustment and it is only insignificant for one model, the Multi-Index model. The implication is that the risk-adjustment models are ineffective in capturing the risk-return relationship.

The choice of risk-adjustment model seems to be fairly inconsequential to the final list of significant attributes: seventeen of the attributes producing significant payoffs are common to all three risk-adjustment procedures. All three risk-adjustment procedures lead to significant attributes in the 'value', 'growth', 'momentum' and 'size and liquidity' style groups. Only the Multi-Index model risk adjustment leads to a significant 'risk' attribute: volatility in 12-month prior returns (SIGMA). The fact that the Multi-Index model leads to the most significant attributes and the fact that one of those attributes is a risk measure, means that the Multi-Index model is less effective than the other two models in explaining the variation in sector returns and controlling for market risk.

The Single-Index and Multi-Index models both result in four significant attributes in the 'size and liquidity' group after risk adjustment. In contrast, the empirical ICAPM results in only one significant attribute, 24-month growth in market value traded to market value (MVTMV-24) which is a liquidity attribute. It is thus conjectured that the empirical ICAPM is more effective at capturing the 'size' effect than the other two risk-adjustment models employed in this study.

Cumulative monthly payoffs are calculated for all the significant sector-specific attributes in the out-sample period using risk-adjusted returns data. The cumulative monthly payoffs illustrate the relative abilities of the attributes to create wealth and also serve to bring out the anomalies more clearly. The attributes are grouped according to style for illustrative and comparative purposes. Appendices C.7, C.8 and C.9 display the evolution of the cumulative payoffs over the out-sample period, as well as the final cumulative payoff as at 31 December 2005 after risk adjustment with the three models.

6.7. Summary and Conclusion

The cross-sectional relationships between worldwide monthly sector returns and sector-specific attributes are tested using OLS regression. The tests are conducted over two periods: in-sample, which runs from 31 January 1995 to 31 December 2001 and out-sample, which runs from 31 January 2002 to 31 December 2005. By running the same regression tests over two sample periods, this study evaluates how robust the significant attributes are to varying time periods. The sector returns are risk-adjusted in the out-sample period using the Single-Index, empirical ICAPM and Multi-Index models as constructed in chapter 5. Risk-adjusting the returns with the three asset-pricing models, allows for the determination of the ability of the sector-specific attributes to explain variation in the returns, above and beyond the ability of these models.

Of the thirteen sector-specific attributes that are significant, at the 5% level, in the in-sample period, nine are also significant in the out-sample period: cash earnings to book value (CB), cash earnings per share to price (CP), 6 and 12-month growth in cash earnings, to price (C-6P & C-12P), dividend yield (DY), 12 and 24-month growth in dividends, to price (D-12P & D-24P), the payout ratio (PO) and the 12-month prior return (MOM-12).

DY and CP fall in the 'value' style group and display positive payoffs of 26.85% and 19.29%, respectively over the in-sample period. C-12P, C-6P, PO, CB, D-12P and D-24P all fall in the 'growth' style group and display positive payoffs from 23.24% for C-12P to 14.64% for D-24P over the in-sample period. MOM-12 is the only 'momentum' attribute common to both sample periods but it displays by far the greatest positive payoff over the in-sample period of 64.66%.

After risk adjustment with the Single-Index, empirical ICAPM and Multi-Index models, twenty-one, nineteen and twenty-three attributes respectively, are still found to be significant. The value, growth and momentum style effects prevail after risk adjustment and, in fact, more attributes within each group become significant after risk adjustment. An even more surprising result is that the 'size and liquidity' style group, which is insignificant in the unadjusted regressions, becomes significant through numerous attributes after risk adjustment. The only common size and liquidity attribute, after the different risk adjustments is 24-month growth in market value traded to market value (MVTMV-24); the empirical ICAPM captures more of the size effect than the other two asset-pricing models. The Multi-Index model appears to capture less of the variation in the sector returns since 12-month volatility in prior returns (SIGMA) becomes significant after risk adjustment with this model.

In conclusion, nine sector-specific attributes exhibit significance, at the 5% level, across worldwide sector indices and are able to explain the variation in sector returns above and beyond the ability of the three asset-pricing models considered in this study.

-7-

Style Timing

"Style consistency ... is not necessarily an optimal strategy. As the asset mix drift creates a need for active asset allocation, the apparent style drift creates a need for style rotation strategies."

-Levis and Liodakis (1999, p.1)

7.1. Introduction

This chapter investigates the relationships between the payoffs to the significant attributes of chapter six and their own lagged values. Seven forecasting models are then constructed and the forecasts are tested for significance.

The monthly payoffs to any particular attribute generally are not consistent in their direction and instead fluctuate from positive to negative over time. Consequently, investing consistently in one style results in a cumulative payoff over any given period, which is the result of compounding all the monthly gains and losses. If the direction of the payoff to the style can be shown to occur in a predictable fashion, then an effective style-timing model allows an investor to alter their position in a style-based portfolio and augment the cumulative payoff to the style by taking advantage of both the positive and negative payoffs. Style-timing models can be used to identify additional attributes, which have the ability to explain sector-specific returns. However, the aim of this chapter is rather to assess whether the performance of the significant attributes from the previous chapter can be improved by using numerous models which predict the direction of the monthly payoffs.

Style momentum is described by Wang (2003, p.3) as "a combination of style rotation and momentum strategies". Essentially, positive autocorrelation within a particular style necessitates consistent momentum investing, whilst negative autocorrelation necessitates inconsistent style rotating. Style momentum is assessed by examination of the autocorrelations and partial autocorrelations up to the twelfth lag, for each significant attribute. A trailing historic mean model, three moving average (MA) models and three exponentially smoothed models are constructed and used to predict attribute payoffs, which are then tested for significance.

Section 7.2 describes the data and methodology whilst section 7.3 presents the empirical results and section 7.4 summarises and concludes.

7.2. Data and Methodology

7.2.1 Style Consistency Assessment

Style consistency refers to the regularity of the direction of the payoffs to any particular attribute. Consistency is assessed for each significant attribute derived in chapter 6, using three different consistency measures.

Every significant attribute from the univariate cross-sectional regression analyses on the unadjusted returns data of the previous chapter is considered in the consistency tests. Consequently, the twenty attributes considered in this chapter are either significant over the in-sample period, the out-sample period or both. The consistency tests are performed over the entire sample period, encompassing both the in and out-sample periods, from 31 January 1995 to 31 December 2005.

The three consistency measures used are (1) the number of times the payoff is positive (negative) as a percentage of the total number of months, (2) the nonparametric Runs test which compares the number of runs of positive and negative payoffs to that expected in a random sample assuming a normal distribution and (3) the number of changes in payoff direction as a percentage of the total possible number of changes.

The first measure can take on values between 0% and 100%. A style which consistently pays off positively will exhibit a ratio closer to 100% whilst a style which consistently pays off negatively will exhibit a ratio closer to 0%. In order to assess the significance of the consistencies of the payoffs to the various attributes, the nonparametric Sign Test is employed under the assumption of binomially distributed data. Under the null hypothesis of the Sign Test, attributes are equally likely to pay off positively as they are to pay off negatively i.e. the first measure should exhibit values, which are not significantly different from 50%. Under the Binomial distribution the probability mass function can be expressed as:

$$P(x) = \binom{N}{x} 0.5^x (1-0.5)^{N-x} \tag{7.1}$$

Where N is the total number of months in the time period under consideration

x is the number of months in which the payoff is positive (negative)

$\binom{N}{x}$ is a statistical combination evaluated as $\frac{N!}{x!(N-x)!}$

The null hypothesis is rejected if the cumulative probability associated with the number of positive (negative) payoffs is greater than (1-p) where p is the level of significance chosen for the test.

The second measure is used to clear up ambiguities which arise under the first measure. If the null hypothesis cannot be rejected under the first measure i.e. the payoff to a particular style is equally likely to be positive or negative, this does not necessarily imply that the style is inconsistent. For example, a style which exhibits only positive payoffs in the first half of the time series and only negative payoffs in the second half will yield exactly the same result, under the first measure, as a style which fluctuates from positive to negative every month. Clearly, only the latter style in the example is inconsistent because it exhibits a high frequency of direction *changes*.

The Runs test accounts for these changes by comparing the number of runs of positive and negative payoffs to a particular attribute to that which would be expected assuming a normal distribution. The Runs test for large samples (where the total number of payoffs is greater than twenty or where the number of positive or negative payoffs is greater than twelve) requires the calculation of an expected number of runs for each attribute and a standard deviation, assuming normally distributed data:

$$\mu_R = \frac{2n_{pos}n_{neg}}{(n_{pos} + n_{neg})} + 1 \tag{7.2}$$

Where μ_R is the expected number of runs in the sample, assuming normally distributed data

n_{pos} is the number of months in which the payoff is positive

n_{neg} is the number of months in which the payoff is negative

$$\sigma_R = \sqrt{\frac{2n_{pos}n_{neg}(2n_{pos}n_{neg} - n_{pos}n_{neg})}{(n_{pos} + n_{neg})^2(n_{pos} + n_{neg} - 1)}} \tag{7.3}$$

Where σ_R is the standard deviation of the runs in the sample, assuming normally distributed data

The mean and standard deviation can then be used to construct a critical region such that if the actual observed number of runs falls outside the bounds of the region, the null hypothesis of randomness in the data can be rejected:

$$\text{Critical Region} = [\mu_R - z_{\alpha/2}\sigma_R; \mu_R + z_{\alpha/2}\sigma_R] \tag{7.4}$$

If the observed number of runs is less than the lower bound of the critical region then it can be inferred that the attribute payoffs are consistent in direction. If the observed number of runs is greater than the upper bound, it can be inferred that the attribute payoffs systematically switch from positive to negative more frequently than expected in a random sample and as such are highly inconsistent. Whereas the Runs test can be used to identify attributes which are consistent in their payoff direction, it cannot be used to rank the attributes by consistency. This inability comes from the fact that the critical regions differ from attribute to attribute because of the differing number of positive and negative payoffs in each time series, which then affect the mean 'and standard deviation.

The third measure, the number of changes in payoff direction as a percentage of the total possible number of direction changes, is employed to assess the relative consistency of the significant attributes and for illustrative purposes. In a time series of N observations there are a total of N possible runs and N-1 possible direction changes. Similarly, if there are k runs of positive and negative payoffs for a given attribute, then there must be k-1 changes in direction payoff.

7.2.2 Style Momentum Assessment

In order to investigate the relationship between the payoff to each style and its own lagged values, a twelve lag correlogram is constructed. Since the data is monthly, any significant autocorrelations should fall within the first twelve lags. Correlograms are constructed in order to test for momentum in all twenty significant attributes of chapter 6. The attributes either produce significant payoffs in the in-sample period, out-sample period or both and momentum is tested over the entire sample period. The correlograms comprise the autocorrelations and partial autocorrelations of the attributes for the first twelve lags.

The sample autocorrelation ρ_k for each lag k is measured by the Pearson (1896) correlation between the time series values which lie k lags apart, notationally:

$$\rho_k = \frac{\sum_{t=k+1}^{N} (\lambda_t - \bar{\lambda})(\lambda_{t-k} - \bar{\lambda})}{\sum_{t=1}^{N} (\lambda_t - \bar{\lambda})^2} \tag{7.5}$$

Where λ_t is the observed monthly attribute payoff at time t

$\bar{\lambda}$ is the time series average of the observed monthly attribute payoffs

N is the number of monthly attribute payoffs in the sample

If ρ_1 is non-zero then there exists first-order serial correlation in the data.

The sample partial autocorrelation at lag k is given by the regression coefficient of λ_{t-k} when λ_t is regressed on constant λ_{t-1}, λ_{t-2}, …, λ_{t-k}. The partial autocorrelation coefficient measures the correlation between values of the time series which lie k lags apart, after controlling for the influence of the intervening lags. If the pattern of autocorrelation is one that can be captured by an autoregression of order less than k, then the partial autocorrelation at lag k will be close to zero. Partial autocorrelations are calculated for lags one to twelve.

The autocorrelations and partial autocorrelations are tested for significance with the following test statistic:

$$\rho_{k,obs} = \rho_k \left(\sqrt{\frac{N-2}{1-\rho_k^2}} \right) \tag{7.6}$$

Where $\rho_{k,obs}$ follows a t-distribution with N-2 degrees of freedom

In addition, the Ljung-Box (1978) Q-statistic (referred to as the 'Q-statistic' for the remainder of this chapter) is employed as a further measure to test the significance of the autocorrelations and partial autocorrelations. The Q-statistic tests the joint null hypothesis that all the autocorrelations or partial autocorrelations up to lag k are equal to zero. Notationally, the Q-statistic can be expressed as:

$$Q_k = N(N+2)\sum_{i=1}^{k}\frac{\rho_i}{N-i} \tag{7.7}$$

Where ρ_i is the ith autocorrelation or partial autocorrelation

If the null hypothesis cannot be rejected, then the Q-statistic follows a chi-squared (χ^2) distribution with k degrees of freedom.

7.2.3 Timing Models

7.2.3.1. The Trailing Historic Mean Model

The first forecasting model is the trailing historic mean (HIST): the non-inclusive trailing means of the payoffs to each attribute are calculated for every month in the time series and used as forecasts for the payoffs. The forecast for the second month in the sample is simply the first month in the sample but as the time series advances, the data set increases in size and so the mean is calculated over more and more observations such that the forecast for the last payoff is the mean of all the previous payoffs.

7.2.3.2. The Moving Average Models

Three trailing moving average (MA) models are constructed, namely the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) models. The MA models are constructed over the entire sample period for every significant attribute by calculating the non-inclusive 6-month, 12-month and 18-month trailing moving averages of the attribute payoffs, which are then used as forecasts of the payoffs in the following month. The moving average forecasts for each attribute are calculated as:

$$\hat{\lambda}_{t+1} = \frac{(\lambda_t + \lambda_{t-1} + \ldots + \lambda_{t-m})}{m} \tag{7.8}$$

Where $\hat{\lambda}_{t+1}$ is the one-month-ahead forecast of the attribute payoff at time $t+1$

λ_t to λ_{t-m} are the actual lagged payoffs to the attribute from times t to $t-m$

m is the order of the moving average model i.e. 6, 12 or 18

7.2.3.3. The Exponential Smoothing Models

Three exponential smoothing models are constructed to forecast the monthly payoffs to the significant attributes. As for the above models, the exponential models are constructed over the entire sample period. The three models are the single exponential smoothing (S-EXP) model, the double exponential smoothing (D-EXP) model and the Holt-Winters exponential smoothing (H-W) model. The S-EXP model is most appropriate for time series data with no linear trend, whilst the D-EXP and H-W models are more appropriate for data with such a trend. The D-EXP and H-W models are similar in that they both assume a linear trend, but the D-EXP is a one-parameter model, whilst the H-W model is a two-parameter model and can thus be argued to be less parsimonious than the D-EXP model but more flexible. To avoid placing prejudgements into the forecasts with regards a trend component, all three models are used to produce forecast payoffs.

The single exponential smoothing model forecasts are calculated as:

$$\hat{\lambda}_{t+1} = \alpha\lambda_t + (1-\alpha)\hat{\lambda}_{t-1} \tag{7.9}$$

Where $\hat{\lambda}_{t+1}$ is the one-month-ahead forecast of the attribute payoff at time $t+1$

λ_t is the actual realised payoff at time t

$\hat{\lambda}_{t-1}$ is the lagged forecast of the attribute payoff at time t-1

α is the smoothing factor

By repeated substitution, the recursion can be re-expressed as:

$$\hat{\lambda}_{t+1} = \alpha\sum_{s=0}^{t-1}(1-\alpha)^s \lambda_{t-s} \tag{7.10}$$

The smoothing factor α lies between zero and one: the closer to zero, the smoother the forecast series. Bowerman and O'Connell (1979) suggest α values between 0.01 and 0.30. The decision as to exactly which value to use can thus be arbitrary and subjective and hence in this study the smoothing factor is chosen by the EViews Statistical package such that for each attribute it minimizes the sum of squares of the one-step-ahead forecast errors.

The double exponential smoothing model forecasts are calculated by repeating the exponential smoothing process on the forecasts derived under single exponential smoothing:

$$\hat{\lambda}^*_{t+1} = \alpha\hat{\lambda}_t + (1-\alpha)\hat{\lambda}^*_{t-1} \tag{7.11}$$

Where $\hat{\lambda}^*_{t+1}$ is the one-month-ahead forecast of the attribute payoff at time $t+1$ under double exponential smoothing

$\hat{\lambda}_t$ is the forecast attribute payoff at time t under single exponential smoothing

$\hat{\lambda}^*_{t-1}$ is the lagged forecast of the attribute payoff at time t-1 under double exponential smoothing

α is the smoothing factor

The smoothing factor again lies in the range from zero to one and is chosen so as to minimize the sum of squares of the one-step-ahead forecast errors.

The Holt-Winters smoothing model forecasts are calculated as:

$$\hat{\lambda}_{t+1} = a_t + b_t \tag{7.12}$$

Where $\hat{\lambda}_{t+1}$ is the one-month-ahead forecast of the attribute payoff at time t+1

a_t is the intercept component at time t

b_t is the trend component at time t

The intercept and trend components are defined by the following recursions:

$$a_t = \alpha\lambda_t + (1-\alpha)(a_{t-1} + b_{t-1}) \tag{7.13}$$

$$b_t = \beta(a_t - a_{t-1}) + (1-\beta)b_{t-1} \tag{7.14}$$

Where λ_t is the actual realised payoff at time t

α and β are smoothing factors

The two smoothing factors are chosen so as to minimize the sum of squares of the one-step-ahead forecast errors such that α is greater than zero and β is less than one.

7.2.3.4. Evaluation Methods

The ability of the seven forecasting models to produce accurate forecasts is tested using three separate measures: (1) the Pearson (1896) correlation between the forecast payoffs and the realised payoffs, (2) the number of times the direction of the payoff was correctly forecast to the total number of months (referred to as the 'Direction ratio' henceforth) and (3) the Theil Inequality Coefficient or U-statistic. The means and standard deviations of the three measures are calculated across all the significant attributes so as to allow overall comparisons to be made between the models.

Notationally, the correlation coefficients are calculated as:

$$r = \frac{\sum_{t=1}^{h}(\hat{\lambda}_t - \sum_{t=1}^{h}\hat{\lambda}_t / h)(\lambda_t - \bar{\lambda})}{\sqrt{\sum_{t=1}^{h}(\hat{\lambda}_t - \sum_{t=1}^{h}\hat{\lambda}_t / h)^2 \sum_{t=1}^{h}(\lambda_t - \bar{\lambda})^2}} \tag{7.15}$$

Where $\hat{\lambda}_t$ is the forecast monthly attribute payoff at time t

λ_t is the realised monthly attribute payoff at time t

$\bar{\lambda}$ is the mean realised monthly attribute payoff

h is the number of forecasts made

$\sum_{t=1}^{h}\hat{\lambda}_t / h$ is the mean forecasted monthly attribute payoff

The correlation measure is similar to the Grinold (1989) Information Coefficient. The correlations are tested for significance by using equation 7.6.

The correlation coefficient is a measure of the strength of the relationship between forecast and realised monthly attribute payoffs, taking on values between one and negative one. A correlation coefficient of one indicates a perfect fit between the two time series, whilst a coefficient between zero and one indicates some kind of positive relationship between the forecasts and the realised payoffs. A coefficient of zero indicates that there is no relationship between the forecasts and the realised payoffs. A negative coefficient indicates a poor model which produces forecasts of the opposite sign to the realised payoffs. The result of employing such a model would be a loss of value.

The Direction ratio is calculated by taking the number of times the direction of the payoff was correctly forecast and dividing it by the total number of months under consideration. The ratios are assumed to be binomially distributed and therefore follow the probability mass function given in equation 7.1. However, in this case, N is now the total number of forecasts made over the entire sample period and x is the number of forecasts where the direction of the payoff was correctly forecast. The nonparametric Sign Test is employed to test the significance of the ratios, under the null hypothesis that the models predict the correct direction of the payoff less than 50% of the time. The test is one-tailed as the models are expected to produce forecasts which perform better in terms of correctly forecasting the direction of the payoff than if the direction was simply chosen at random. The null hypothesis is rejected if the cumulative probability associated with the number of correct direction forecasts is greater than (1-*p*) where *p* is the level of significance chosen for the test. The closer the direction ratio is to one, the more accurate the model in that it correctly forecasts the direction of the payoff most of the time.

A weakness of the direction ratio is that it does not consider the magnitude of the payoffs when the payoff direction is correctly or incorrectly forecast. Consider, for example, a model which has an insignificant direction ratio but correctly predicts the direction of the payoff when the magnitude of the payoff is large, and incorrectly predicts the direction of the payoff when the magnitude of the payoff is small. Such a model could still be of value.

Theil's Inequality Coefficient, also known as the U-statistic is calculated as:

$$U = \frac{\sqrt{\sum_{t=1}^{h} (\hat{\lambda}_t - \lambda_t)^2 / h}}{\sqrt{\sum_{t=1}^{h} \hat{\lambda}_t^2 / h} + \sqrt{\sum_{t=1}^{h} \lambda_t^2 / h}} \tag{7.16}$$

The U-statistic lies between zero and one; the closer the value is to zero, the better the fit between the forecasts and the realised payoffs (see Pindyck and Rubinfeld, 1998). The U-statistic is used as the primary measure to evaluate the accuracy of the forecasts because it is a scale-invariant measure, which allows more accurate comparisons to be made between the different models.

Theil (1958) extracts further value from the U-statistic by decomposing the mean squared forecast error into three components, namely the bias (U^M), the variance (U^S) and the covariance (U^C), which are calculated as:

$$U^M = \frac{((\sum_{t=1}^{h} \hat{\lambda}_t / h) - \bar{\lambda})^2}{\sum_{t=1}^{h} (\hat{\lambda}_t - \lambda_t)^2 / h} \tag{7.17}$$

$$U^S = \frac{(s_{\hat{\lambda}} - s_{\lambda})^2}{\sum_{t=1}^{h} (\hat{\lambda}_t - \lambda_t)^2 / h} \tag{7.18}$$

$$U^C = \frac{2(1-r) s_{\hat{\lambda}} s_{\lambda}}{\sum_{t=1}^{h} (\hat{\lambda}_t - \lambda_t)^2 / h} \tag{7.19}$$

Where $s_{\hat{\lambda}}$ is the biased[1] standard deviation of the forecast monthly attribute payoffs

s_{λ} is the biased standard deviation of the realised monthly attribute payoffs

r is the correlation coefficient between the forecasts and the realised monthly attribute payoffs as defined in equation 7.15

The above decomposition is useful in that it allows systematic error, associated with the model, to be separated from non-systematic or random error. More explicitly, the bias measures the extent to which the mean of the forecasts differs from the mean of the realised values, thus indicating the level of systematic error. The variance measures the ability of the forecasting model to replicate the level of variation in the actual realised time series of payoffs, and the covariance measures the remaining unsystematic forecasting error. Pindyck and Rubinfeld (1998) and Theil (1958) suggest that for an accurate forecasting model the bias and variance should approach zero, whilst the covariance approaches one.

[1] The biased and unbiased standard deviations differ in the degrees of freedom used in their denominators. The biased standard deviation assumes n degrees of freedom whilst the unbiased standard deviation assumes n-1 degrees of freedom (using the first moment i.e. the mean to calculate the standard deviation reduces the degrees of freedom by one), where n is the number of observations under consideration:

Biased Standard Deviation = $\frac{1}{n}\sum_{t=1}^{n}(\lambda_t - \bar{\lambda})^2$; Unbiased Standard Deviation = $\frac{1}{n-1}\sum_{t=1}^{n}(\lambda_t - \bar{\lambda})^2$

7.3. Empirical Results

7.3.1 Style Consistency Results

Figure 7.1 gives an indication as to the consistency of the direction of the monthly style payoffs. The proportions of positive payoffs are displayed in black, whilst the proportions of negative payoffs are displayed in light grey. Attributes which consistently pay off positively have ratios close to 100%, whilst ratios which consistently pay off negatively have ratios close to 0%. Attributes with ratios close to 50% could be inconsistent in their payoff direction but the frequency of direction changes must also be considered: true inconsistency also requires a high frequency of direction changes (displayed in figure 7.2).

All the attributes pay off consistently in the positive direction at the 5% level of significance when tested with the nonparametric Sign Test. 12-month growth in cash earnings, to price (C-12P) is the most consistent, paying off in the positive direction 74.81% of the time, whilst 12-month growth in earnings, to price (E-12P) is the least consistent, paying off in the positive direction only 57.25% of the time.

Figure 7.1: Consistency in Monthly Style Payoffs for All Significant Attributes

The figure displays the proportions of positive and negative monthly payoffs to all the significant attributes. The percentages of positive payoffs are displayed in black, whilst the percentages of negative payoffs are displayed in light grey. Attributes which pay off consistently have ratios closer to 0% or 100%. Dashed lines indicate the 50% level and the 5% significance levels as determined by the nonparametric Sign Test. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

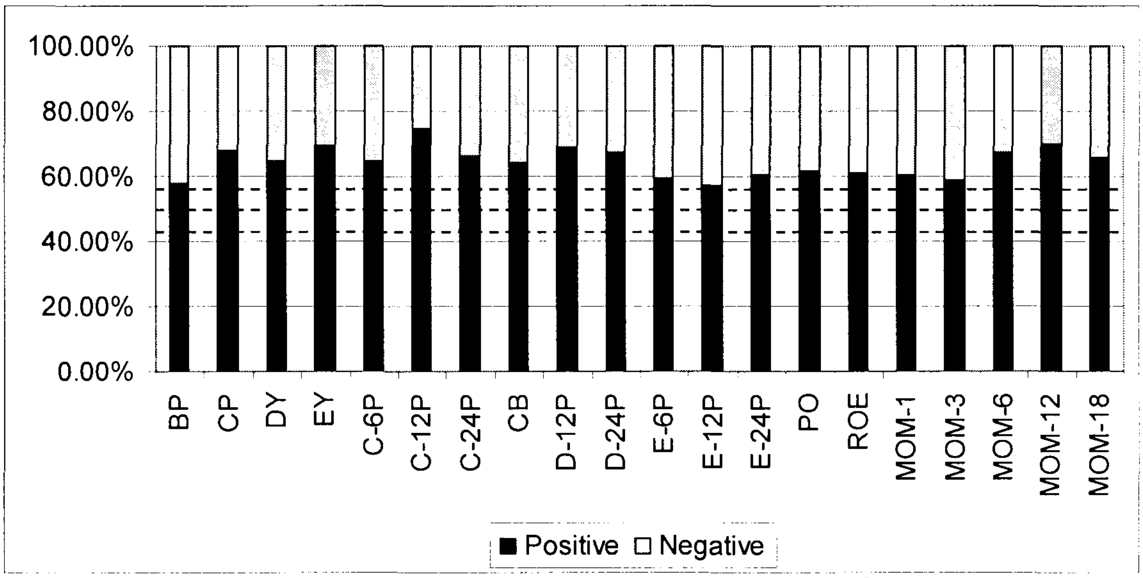


Table 7.1 displays the expected number of runs and the standard deviation of the runs expected in a random sample, assuming a normal distribution of data in the time series. From these two statistics a critical region is constructed at the 95% level of confidence and the upper and lower bounds of the region are displayed along with the actual observed number of runs for each significant attribute. If the observed number of runs falls below the lower bound of the critical region, then the payoffs to the attribute are significantly consistent in their payoff direction and are displayed in bold font.

Nine of the twenty significant attributes are found to be consistent in their payoff direction, namely book value per share to price (BP), dividend yield (DY), earnings yield (EY), 6-month growth in cash earnings, to price (C-6P), cash earnings to book value (CB), 24-month growth in dividends, to price (D-24P), 24-month growth in earnings, to price (E-24P) and 12-month and 18-month prior return (MOM-12 & MOM-18).

Table 7.1: Runs Tests for Consistency in Monthly Style Payoff Direction

The table shows for each attribute the expected number of runs in a random sample and the associated standard deviation, assuming a normal distribution. In addition, the 95% critical region constructed from the mean and standard deviation and the actual observed number of runs are shown. Where the actual observed number of runs is less than the lower bound of the critical region, the attribute payoffs are significantly consistent in direction at the 5% level of significance and are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Expected Number of Runs	Standard Deviation of Runs	Critical Region (Upper Bound)	Critical Region (Lower Bound)	Number of Runs
Value	BP	64.817	5.553	73.951	55.683	**49**
	CP	58.069	4.961	66.229	49.908	50
	DY	60.695	5.192	69.234	52.155	**50**
	EY	56.573	4.830	64.517	48.628	**42**
Growth	C-6P	60.695	5.192	69.234	52.155	**49**
	C-12P	50.374	4.286	57.424	43.324	52
	C-24P	59.443	5.082	67.801	51.084	53
	CB	61.275	5.242	69.898	52.652	**51**
	D-12P	57.336	4.897	65.391	49.281	52
	D-24P	58.771	5.023	67.033	50.509	**50**
	E-6P	64.115	5.491	73.147	55.082	62
	E-12P	65.122	5.580	74.300	55.944	64
	E-24P	63.718	5.457	72.693	54.742	**54**
	PO	62.832	5.379	71.680	53.984	59
	ROE	63.290	5.419	72.204	54.376	67
Momentum	MOM-1	63.718	5.457	72.693	54.742	63
	MOM-3	64.481	5.524	73.566	55.395	67
	MOM-6	58.771	5.023	67.033	50.509	59
	MOM-12	55.779	4.760	63.609	47.949	**45**
	MOM-18	60.084	5.138	68.535	51.633	**49**

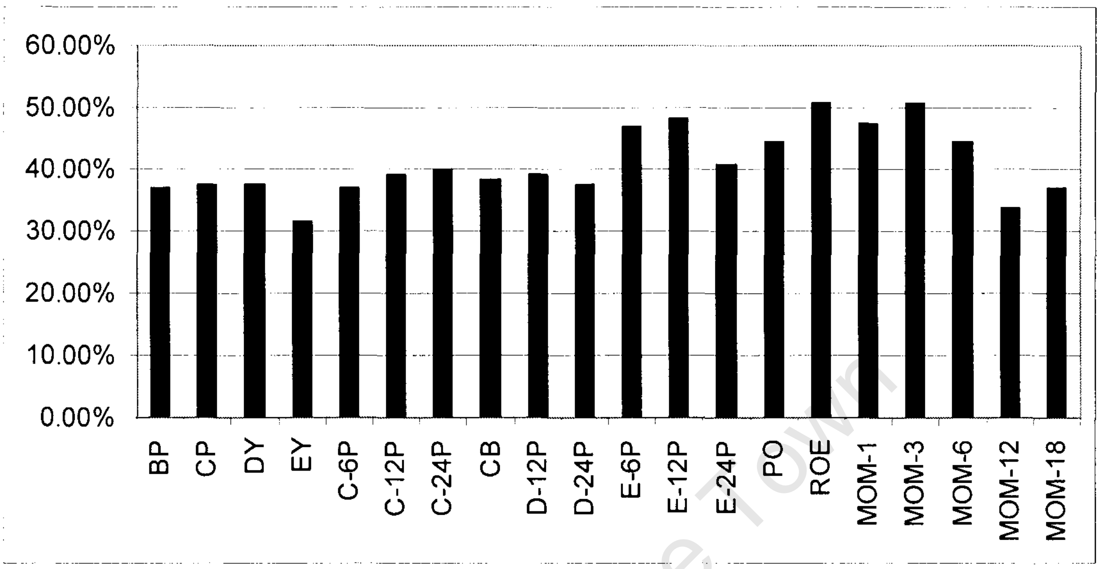
Figure 7.2 displays the frequency of attribute payoff direction changes as a percentage of the total number of possible changes over the entire sample period. The lower the frequency of direction changes the more consistent the style.

The same nine significantly consistent attributes from the Runs tests are shown to be consistent in their payoff direction in figure 7.2. Whilst this is not surprising given that the two approaches are inherently very similar, the frequency of direction changes graph allows for the relative consistency of the attributes to be assessed, whereas the Runs test only allows for their identification.

Earnings yield (EY) is found to be the most consistent attribute, changing payoff direction only 31.54% of the time. C-12P which was the most consistent attribute in figure 7.1 is not found to be consistent with the Runs test because it changes direction 39.23% of the time. The return on equity (ROE) and 3-month prior return (MOM-3) are the least consistent attributes, both changing payoff direction 50.77% of the time. These results are not incongruent with those of figure 7.1, where ROE and MOM-3, whilst still paying off significantly more in the positive direction than in the negative direction, can be seen to be less significant than most of the other attributes.

Figure 7.2: Frequency of Changes in Monthly Style Payoff Direction

The figure displays the number of times the payoffs changed direction as a percentage of the total possible number of changes. Attributes which are more consistent have lower ratios. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.



The consistency of the styles exhibited in this study tends to contrast the general literature. Macedo (1995) suggests that value and growth strategies are complimentary and that investors should switch between them. Kahn (1996) supports this notion and finds that the majority of American mutual funds tend to swap from value to growth strategies with only a few simultaneously pursuing both. The results of this study would indicate that holding both could be profitable and that switching is not required because both value and growth attributes are shown to pay off consistently. This finding is supported by Indro, Jiang, Hu and Lee (1998) as they show that funds which are consistent in their value-growth investment style perform no worse than inconsistent funds and that funds which are inconsistent in their value-growth and size styles are actually the worst performing.

7.3.2 Style Momentum Results

The autocorrelations, partial autocorrelations and p-values associated with the Ljung-Box Q-statistics for the entire sample period are displayed in tables 7.2 to 7.4, respectively. The Ljung-Box Q-statistics are displayed in appendix D.1. All statistics which are significant at the 5% level of significance are displayed in bold.

Autocorrelation is found to exist at some lag in every significant attribute except for 6-month prior return (MOM-6). Autocorrelation tends to be stronger at the first, sixth and eleventh lags but exists in at least one attribute at all lags except for lags three and nine.

Table 7.2: Autocorrelations of Monthly Payoffs to Significant Attributes

The table shows the Pearson (1896) correlations between the payoffs to the significant attributes and their lagged values from lags one to twelve. Correlations which are significant at the 5% level, as determined by the test statistic of equation 7.6, are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

		Lags											
Style Group	**Attribute**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Value	**BP**	**0.393**	**0.182**	0.130	0.116	**0.225**	**0.261**	**0.285**	0.089	-0.012	-0.108	-0.020	0.040
	CP	0.131	0.008	0.104	0.007	0.074	**0.179**	0.005	0.071	0.043	-0.080	0.045	0.088
	DY	**0.353**	0.140	0.030	0.046	**0.182**	0.158	**0.227**	0.026	-0.038	-0.103	-0.011	0.041
	EY	0.163	0.097	0.153	0.084	**0.225**	**0.262**	**0.245**	0.085	0.006	-0.073	0.085	**0.188**
Growth	**C-6P**	**0.256**	**0.199**	0.115	-0.010	-0.039	-0.099	0.008	-0.153	0.010	0.014	0.044	0.149
	C-12P	0.149	0.094	0.045	-0.024	-0.033	**-0.191**	-0.014	**-0.221**	-0.057	-0.021	-0.040	0.002
	C-24P	**0.179**	0.142	0.061	-0.105	-0.090	-0.054	0.066	-0.029	0.023	-0.089	**-0.208**	-0.118
	CB	**0.220**	**0.330**	-0.040	0.054	0.008	0.165	0.110	0.094	-0.016	-0.091	**-0.182**	**-0.215**
	D-12P	**0.321**	0.007	-0.084	-0.126	0.013	0.088	0.028	0.053	-0.058	**-0.219**	**-0.188**	-0.052
	D-24P	**0.363**	0.168	-0.006	-0.070	-0.016	0.147	0.070	0.094	0.016	**-0.206**	**-0.243**	**-0.191**
	E-6P	**0.181**	0.108	-0.050	0.096	0.146	**0.186**	0.095	-0.108	-0.014	-0.014	0.032	-0.054
	E-12P	**0.285**	0.023	-0.020	0.024	0.026	0.049	-0.044	-0.058	0.033	-0.045	**-0.200**	-0.065
	E-24P	**0.185**	0.134	0.066	0.042	0.077	0.159	0.080	-0.025	0.027	-0.093	-0.155	-0.030
	PO	0.167	0.036	-0.106	-0.018	0.028	0.040	0.020	-0.004	-0.025	**-0.226**	-0.117	-0.105
	ROE	**0.174**	0.054	0.136	0.034	0.089	0.127	0.042	-0.045	0.029	-0.135	-0.122	-0.071
Momentum	**MOM-1**	0.046	0.047	-0.036	**-0.231**	0.037	0.014	-0.085	0.103	-0.013	0.077	-0.019	-0.054
	MOM-3	-0.019	0.075	0.004	**-0.218**	0.067	0.005	0.023	0.104	-0.066	0.113	-0.060	0.055
	MOM-6	0.167	-0.037	-0.082	-0.150	-0.056	-0.023	0.070	0.162	0.032	0.114	0.027	0.063
	MOM-12	**0.303**	0.017	-0.090	-0.115	0.084	0.104	0.102	0.035	-0.046	0.035	0.032	0.065
	MOM-18	**0.385**	0.098	0.017	0.015	0.129	0.115	0.110	0.013	0.040	-0.048	-0.011	0.081

The partial autocorrelation coefficient at each lag is the correlation between the payoff and its lagged value after controlling for the intervening lags. Partial autocorrelation exists at some lag for every significant attribute except for cash earnings per share to price (CP) and 6-month prior return (MOM-6). Partial autocorrelation tends to be strongest at the first and tenth lags but exists in at least one attribute at all lags except for nine and twelve.

Table 7.3: Partial Autocorrelations of Monthly Payoffs to Significant Attributes

The table shows the partial autocorrelations between the payoffs to the significant attributes and their lagged values from lags one to twelve. The partial correlation coefficient measures the correlation between values of the series *k* lags apart after controlling for the influence of the intervening lags. Correlations which are significant at the 5% level, as determined by the test statistic of equation 7.6, are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

		Lags											
Style Group	**Attribute**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Value	**BP**	**0.393**	0.033	0.056	0.051	**0.183**	0.130	0.148	-0.120	-0.080	**-0.174**	0.012	-0.029
	CP	0.131	-0.010	0.106	-0.021	0.080	0.153	-0.035	0.069	-0.007	-0.085	0.036	0.049
	DY	**0.353**	0.017	-0.028	0.047	**0.177**	0.042	0.158	-0.122	-0.042	-0.108	0.042	-0.024
	EY	0.163	0.072	0.131	0.038	**0.197**	**0.197**	**0.180**	-0.022	-0.090	**-0.200**	-0.007	0.086
Growth	**C-6P**	**0.256**	0.143	0.038	-0.078	-0.049	-0.077	0.075	-0.149	0.082	0.026	0.051	0.111
	C-12P	0.149	0.074	0.022	-0.041	-0.031	**-0.184**	0.046	**-0.208**	0.015	-0.002	-0.027	-0.032
	C-24P	**0.179**	0.114	0.018	-0.140	-0.066	0.001	0.116	-0.058	-0.007	-0.117	**-0.173**	-0.036
	CB	**0.220**	**0.296**	**-0.180**	-0.006	0.083	0.152	0.038	-0.041	-0.056	-0.093	-0.143	-0.160
	D-12P	**0.321**	-0.107	-0.059	-0.088	0.088	0.049	-0.034	0.060	-0.086	**-0.180**	-0.079	0.029
	D-24P	**0.363**	0.042	-0.092	-0.055	0.048	**0.179**	-0.056	0.043	-0.021	**-0.231**	-0.116	-0.045
	E-6P	**0.181**	0.077	-0.085	0.116	0.130	0.122	0.038	-0.158	0.017	-0.021	-0.035	-0.075
	E-12P	**0.285**	-0.063	-0.010	0.038	0.008	0.042	-0.074	-0.025	0.064	-0.090	**-0.179**	0.055
	E-24P	**0.185**	0.103	0.026	0.014	0.061	0.136	0.019	-0.082	0.022	-0.105	-0.156	0.011
	PO	0.167	0.009	-0.117	0.019	0.037	0.018	0.008	-0.004	-0.018	**-0.226**	-0.049	-0.073
	ROE	**0.174**	0.024	0.126	-0.012	0.082	0.087	0.002	-0.080	0.024	-0.163	-0.083	-0.063
Momentum	**MOM-1**	0.046	0.045	-0.040	**-0.231**	0.064	0.035	-0.116	0.064	0.019	0.072	-0.074	-0.013
	MOM-3	-0.019	0.075	0.006	**-0.225**	0.063	0.046	0.014	0.054	-0.042	0.111	-0.047	0.071
	MOM-6	0.167	-0.066	-0.066	-0.131	-0.017	-0.031	0.060	0.122	-0.020	0.134	0.020	0.118
	MOM-12	**0.303**	-0.082	-0.078	-0.068	0.152	0.026	0.053	-0.005	-0.023	0.078	0.000	0.040
	MOM-18	**0.385**	-0.059	0.000	0.017	0.139	0.017	0.063	-0.059	0.070	-0.117	0.044	0.063

The Ljung-Box Q-statistic tests the joint null hypothesis that all the autocorrelations up to the *k*th lag are simultaneously equal to zero. The null hypothesis is rejected at most lags for book value per share to price (BP), dividend yield (DY), earnings yield (EY), 6-month growth in cash earnings, to price (C-6P), cash earnings to book value (CB), 12-month and 24-month growth in dividends, to price (D-12P & D-24P), 6-month growth in earnings, to price (E-6P), 12-month and 18-month prior return (MOM-12 & MOM-18). The results indicate that at least one of the autocorrelations is significantly different from zero. These results support those of the autocorrelation and partial autocorrelation tests, where the above mentioned attributes are also found to have significant autocorrelations and partial autocorrelations.

Table 7.4: Ljung-Box p-values of Monthly Payoffs to Significant Attributes

The table shows the p-values associated with the Ljung-Box Q-statistics for significant in-sample attribute payoffs for lags one to twelve. P-values below 5% are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

		Lags											
Style Group	**Attribute**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Value	**BP**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	CP	0.128	0.314	0.285	0.434	0.473	0.172	0.250	0.284	0.350	0.363	0.425	0.418
	DY	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	EY	0.060	0.090	**0.045**	0.061	**0.007**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Growth	**C-6P**	**0.003**	**0.001**	**0.001**	**0.003**	**0.006**	**0.007**	**0.014**	**0.008**	**0.013**	**0.022**	**0.031**	**0.018**
	C-12P	0.085	0.125	0.218	0.340	0.457	0.134	0.200	**0.033**	**0.046**	0.069	0.094	0.132
	C-24P	**0.038**	**0.030**	0.057	0.060	0.070	0.102	0.131	0.185	0.250	0.251	0.065	0.053
	CB	**0.011**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.000**	**0.000**
	D-12P	**0.000**	**0.001**	**0.002**	**0.002**	**0.005**	**0.006**	**0.011**	**0.017**	**0.025**	**0.004**	**0.001**	**0.002**
	D-24P	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.000**	**0.000**	**0.000**
	E-6P	**0.036**	**0.050**	0.097	0.108	0.062	**0.018**	**0.020**	**0.019**	**0.032**	**0.050**	0.071	0.091
	E-12P	**0.001**	**0.004**	**0.012**	**0.026**	**0.048**	0.074	0.108	0.141	0.192	0.241	0.071	0.086
	E-24P	**0.032**	**0.030**	0.055	0.097	0.123	0.058	0.070	0.106	0.150	0.150	0.081	0.110
	PO	0.054	0.142	0.143	0.242	0.349	0.445	0.555	0.662	0.744	0.208	0.171	0.154
	ROE	**0.043**	0.107	0.073	0.129	0.144	0.106	0.151	0.201	0.266	0.184	0.144	0.163
Momentum	**MOM-1**	0.592	0.745	0.859	0.088	0.142	0.216	0.230	0.211	0.285	0.304	0.381	0.429
	MOM-3	0.824	0.667	0.847	0.118	0.157	0.239	0.327	0.295	0.333	0.281	0.322	0.368
	MOM-6	0.054	0.142	0.186	0.095	0.139	0.210	0.246	0.119	0.166	0.139	0.186	0.214
	MOM-12	**0.000**	**0.002**	**0.004**	**0.004**	**0.006**	**0.007**	**0.008**	**0.013**	**0.020**	**0.031**	**0.046**	0.057
	MOM-18	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.002**	**0.004**	**0.004**

Generally, the attributes seem to exhibit a fair amount of autocorrelation and do not contravene the predictions made by Barberis and Shleifer (2003) who predict a rich pattern of own and cross-correlations in style based investment strategies.

7.3.3 Timing Models Results

The Pearson (1896) correlations between the actual realised payoffs of the significant attributes and the forecast payoffs made by the seven forecasting models are calculated. The attributes under consideration are those which produce significant payoffs in either the in-sample period, out-sample period or both. All seven models are used to produce one-month-ahead forecasts which are non-inclusive so as to avoid look-ahead bias.

Table 7.5 shows the correlations for each forecasting model and attribute, with the attributes being grouped according to style. Correlation coefficients which are significant at the 5% level of significance are displayed in bold. The mean and standard deviation of the correlations (across all the significant attributes) are displayed for each forecasting model in figure 7.3.

The historic mean model (HIST) performs poorly in forecasting attribute payoffs, yielding no significant positive correlations and one significant negative correlation.

The majority of the correlations produced by the HIST model are negative, indicating that the model is highly inaccurate: the use of such a model would thus lead to a loss of value.

The moving average models perform better than the HIST model, especially with the 'value' attributes. The 6-month moving average (MA-6) model is the best performing of the seven models, producing significant positive correlations with all the 'value' attributes, five 'growth' attributes and one 'momentum' attribute. The 12-month (MA-12) and 18-month (MA-18) moving average models are less impressive, producing three significant positive 'value' group correlations, no significant positive 'growth' group correlations and one significant positive 'momentum' group correlation in the case of the MA-12 model.

The performance of the exponential models is similar to that of the MA-12 and MA-18 models. The single exponential smoothing (S-EXP) model yields three significant positive correlations in the 'value' group whilst the double exponential smoothing (D-EXP) model and the Holt-Winters exponential smoothing (H-W) model both yield four. Like the MA-12 and MA-18 models, the exponential models do not perform well on the 'growth' or 'momentum' attributes, with the S-EXP model yielding three significant negative correlations in the 'growth' group, the D-EXP model yielding no significant correlations and H-W model yielding only one significant positive correlation.

Table 7.5: Correlations of Actual Payoffs and Model Forecasts for Significant Attributes

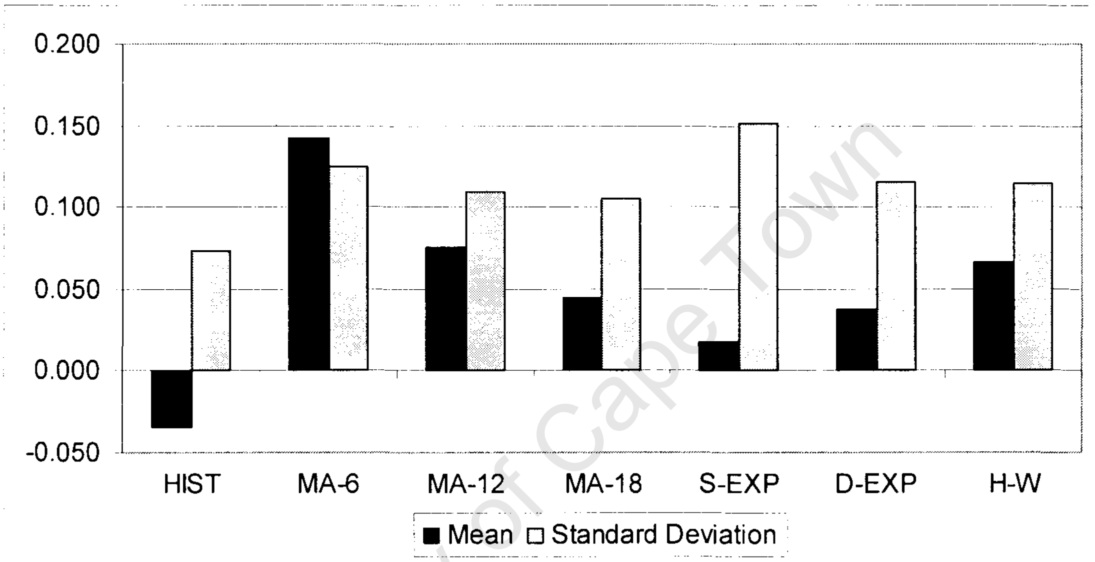
The table shows the Pearson (1896) correlations between the significant attribute payoffs and the payoffs forecast by the historic mean (HIST) model, the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average (MA) models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The correlations relate to the payoffs and forecasts made over the entire sample period from 31 January 1995 to 31 December 2005. Correlations which are significant at the 5% level, as determined by the test statistic of equation 7.6, are displayed in bold. The greater the correlation, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	HIST	MA-6	MA-12	MA-18	S-EXP	D-EXP	H-W
Value	**BP**	0.119	**0.372**	**0.260**	**0.222**	**0.270**	**0.265**	**0.266**
	CP	0.059	**0.193**	0.151	0.165	**0.175**	**0.184**	**0.218**
	DY	0.020	**0.273**	**0.207**	**0.192**	0.170	**0.185**	**0.187**
	EY	0.010	**0.312**	**0.283**	**0.246**	**0.261**	**0.274**	**0.265**
Growth	**C-6P**	-0.073	0.146	0.129	0.145	0.067	0.049	0.074
	C-12P	**-0.190**	0.023	-0.088	-0.041	**-0.231**	-0.095	-0.129
	C-24P	-0.171	0.051	-0.061	-0.023	-0.056	-0.052	-0.049
	CB	-0.024	**0.225**	0.074	-0.088	0.171	-0.026	**0.187**
	D-12P	0.042	0.074	-0.052	-0.011	-0.076	0.011	-0.008
	D-24P	-0.057	**0.180**	0.029	-0.035	0.070	-0.020	0.060
	E-6P	-0.050	**0.226**	0.118	0.054	0.079	-0.075	0.082
	E-12P	-0.125	0.134	0.006	0.011	**-0.201**	-0.076	-0.022
	E-24P	-0.072	**0.216**	0.101	0.028	0.084	0.029	0.120
	PO	-0.007	0.059	-0.081	-0.126	**-0.227**	0.038	-0.051
	ROE	-0.015	**0.207**	0.072	0.020	-0.082	0.037	0.090
Momentum	**MOM-1**	0.004	-0.077	-0.042	-0.068	-0.052	-0.001	-0.089
	MOM-3	-0.045	-0.040	0.025	-0.015	-0.018	-0.012	0.043
	MOM-6	-0.049	-0.072	0.079	0.030	-0.104	-0.148	-0.001
	MOM-12	-0.023	0.105	0.124	0.063	-0.051	0.103	-0.018
	MOM-18	-0.035	**0.230**	**0.186**	0.115	0.110	0.071	0.102

Figure 7.3 supports the findings of table 7.5 in that the MA-6 model is again clearly the best performing model with a mean correlation of 14.20% and the HIST model is the worst performing with a mean correlation of -3.40%. The MA-18 model is the worst performing moving average model with a mean correlation of 4.40%. The H-W model is the best performing exponential smoothing model whilst the S-EXP is the worst, with mean correlations of 6.60% and 1.80%, respectively. All the models suffer from high standard deviations, which with the exception of the MA-6 model tend to swamp the mean correlations. The implication is that the models are all fairly inaccurate because of the large variation in the correlations produced.

Figure 7.3: Average Correlations of Significant Attributes by Forecasting Model

The figure displays the means and standard deviations of the Pearson (1896) correlations between the significant attribute payoffs and the payoffs forecast by the historic mean (HIST) model, the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average (MA) models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The means are displayed by model, averaging across the significant attributes. The means are displayed in black and the standard deviations in light grey. The correlations relate to the payoffs and forecasts made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the mean correlation, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. The data was obtained from Datastream International at the University of Cape Town.



The direction ratios of the significant attributes are calculated for each forecasting model and displayed in table 7.6, with the attributes being grouped according to style. Direction ratios which are significant at the 5% level of significance are displayed in bold. The mean and standard deviation of the direction ratios (across all the significant attributes) are displayed for each forecasting model in figure 7.4.

All seven forecasting models perform well in terms of correctly forecasting the payoff direction. The HIST and MA-18 models are the most successful, each yielding significant direction ratios for all the significant attributes. The MA-6 and H-W models are the least successful but still yield significant direction ratios in thirteen out of the twenty cases.

Table 7.6: Direction Ratios for Significant Attributes

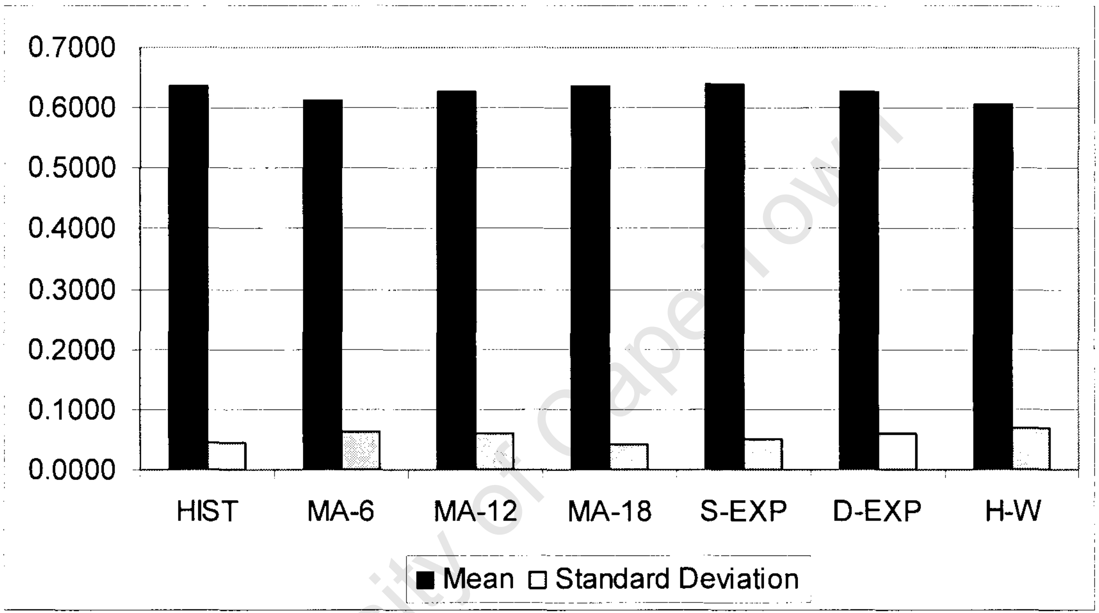
The table shows the direction ratios of the forecasts made for the significant attributes by the historic mean (HIST) model, the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average (MA) models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The direction ratios show the number of times the direction of the payoff was correctly forecast by the forecasting models, to the total number of forecasts made. The direction ratios relate to the forecasts made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the direction ratio, the better the style timing model performs. Direction ratios which are significant at the 5% level under the nonparametric sign test are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	HIST	MA-6	MA-12	MA-18	S-EXP	D-EXP	H-W
Value	BP	**0.577**	**0.656**	**0.605**	**0.664**	**0.615**	**0.615**	**0.615**
	CP	**0.669**	**0.632**	**0.605**	**0.664**	**0.662**	**0.692**	**0.685**
	DY	**0.646**	**0.664**	**0.655**	**0.655**	**0.638**	**0.638**	**0.631**
	EY	**0.662**	**0.712**	**0.714**	**0.717**	**0.723**	**0.731**	**0.692**
Growth	C-6P	**0.654**	**0.576**	**0.655**	**0.655**	**0.654**	**0.654**	**0.608**
	C-12P	**0.738**	**0.736**	**0.765**	**0.726**	**0.746**	**0.746**	**0.746**
	C-24P	**0.662**	**0.616**	**0.672**	**0.637**	**0.662**	**0.638**	**0.615**
	CB	**0.638**	**0.632**	**0.630**	**0.584**	**0.577**	**0.638**	0.538
	D-12P	**0.685**	0.560	**0.597**	**0.619**	**0.685**	**0.569**	**0.569**
	D-24P	**0.669**	**0.656**	**0.664**	**0.628**	**0.685**	**0.631**	**0.646**
	E-6P	**0.585**	0.536	**0.597**	**0.628**	0.562	0.531	0.531
	E-12P	**0.569**	0.568	**0.597**	**0.611**	**0.569**	**0.569**	0.562
	E-24P	**0.600**	0.560	0.555	**0.628**	**0.608**	**0.569**	0.531
	PO	**0.615**	**0.584**	**0.580**	**0.584**	**0.615**	**0.615**	**0.608**
	ROE	**0.608**	0.536	**0.605**	**0.593**	**0.608**	0.554	0.508
Momentum	MOM-1	**0.585**	0.560	0.487	**0.575**	**0.600**	**0.577**	0.538
	MOM-3	**0.577**	0.520	**0.580**	**0.584**	**0.585**	**0.585**	0.538
	MOM-6	**0.669**	**0.584**	**0.655**	**0.690**	**0.669**	**0.669**	**0.669**
	MOM-12	**0.700**	**0.680**	**0.672**	**0.628**	**0.700**	**0.700**	**0.708**
	MOM-18	**0.646**	**0.664**	**0.672**	**0.646**	**0.608**	**0.623**	**0.592**

The mean direction ratios are all in excess of 60%, indicating that on average the forecasting models can fairly accurately forecast attribute payoff direction but not necessarily payoff magnitude. The standard deviations are all less than 7% and thus small in comparison to the means, implying a high level of accuracy in the direction of the forecasts. The HIST and MA-18 models are confirmed as the best performing models in terms of payoff direction forecasting. The HIST model has a higher mean direction ratio of 63.77% versus 63.58% for the MA-18 model but the HIST model suffers from a slightly higher standard deviation of 4.66% versus 4.27% for the MA-18 model. The H-W model is the worst performing model with a mean direction ratio of 60.65% and a standard deviation of 6.81%.

Figure 7.4: Average Direction Ratios of Significant Attributes by Forecasting Model

The figure displays the means and standard deviations of the direction ratios of the forecasts made for the significant attributes by the historic mean (HIST) model, the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average (MA) models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The direction ratios show the number of times the direction of the payoff was correctly forecast by the forecasting models, to the total number of forecasts made. The means are displayed by model, averaging across the significant attributes. The means are displayed in black and the standard deviations in light grey. The direction ratios relate to the forecasts made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the mean direction ratio, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. The data was obtained from Datastream International at the University of Cape Town.



The moderate performance of the forecasting models is surprising and in opposition to the findings of Haugen and Baker (1996) who are able to successfully time twelve firm-specific styles. However, the results are supported by Levis and Liodakis (1999) who find that style rotation is only marginally successful when considering value and growth strategies and Coggin (1998) who concludes that styles cannot be predicted purely on the basis of the time series of values.

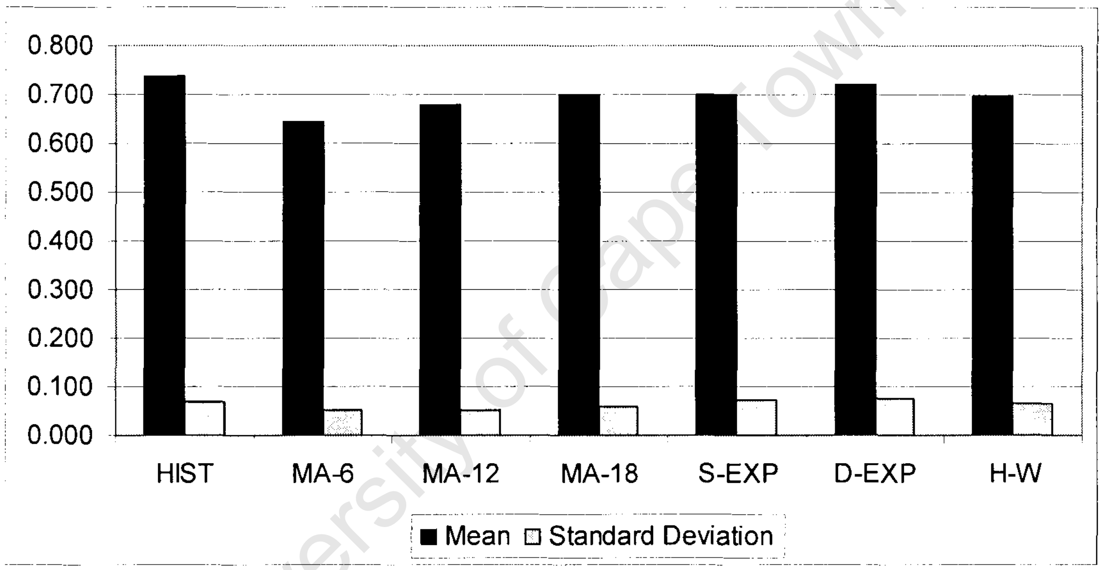
The Theil Inequality Coefficients or U-statistics of the significant attributes are calculated for each forecasting model. The mean and standard deviation of the U-statistics (across all the significant attributes) are displayed for each forecasting model in figure 7.5.

The mean U-statistics are poor for all seven forecasting models and support the results of the correlation tests earlier in the chapter. The mean U-statistics are all in excess of

0.60 and suggest that the forecasting models are all fairly inaccurate in forecasting attribute payoffs.

Figure 7.5: Average Theil Inequality Coefficients of Significant Attributes by Forecasting Model

The figure displays the means and standard deviations of the Theil (1958) Inequality Coefficients of the forecasts made for the significant attributes by the historic mean (HIST) model, the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average (MA) models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The Theil Inequality Coefficient lies between zero and one: the closer the coefficient is to the zero, the better the style-timing model. The means are displayed by model, averaging across the significant attributes. The means are displayed in black and the standard deviations in light grey. The Theil Inequality Coefficients relate to the forecasts made over the entire sample period from 31 January 1995 to 31 December 2005. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. The data was obtained from Datastream International at the University of Cape Town.



Appendices D.2 to D.8 display all the forecasting statistics for all seven forecasting models and for all twenty significant attributes. The forecasting statistics include the correlation coefficients, the direction ratios (and associated p-values), the U-statistics, the bias, the variance and the covariance.

All seven models seem to possess little structural bias i.e. the mean attribute payoff forecasts are not significantly different to the actual realised mean payoffs. The HIST model has the highest mean structural bias at 0.80% whilst the moving average models all possess no structural bias.

Differences between the models do arise in the dispersion of the variance. On average the MA-6 model is able to most successfully replicate the variance of the actual time series of payoffs, with a mean variance statistic of 22.00%. The HIST model is the worst performing in this regard with a mean variance statistic of 70.60%. On average the moving average models are better at capturing the variation in the actual time series than the exponential smoothing models. The mean covariance figures, which measure the proportion of unsystematic forecasting error can be used to confirm the above results because in it is known that the bias, variance and covariance portions must add up to one, and if the bias is negligible, then whatever variation is not systematic (variance), must be unsystematic (covariance).

7.4. Summary and Conclusion

Style consistency, style momentum and the use of style timing models are all investigated. Three measures are used to assess consistency: the proportion of times the attribute is positive (negative), the nonparametric Runs test and the number of direction changes as a percentage of the total number of months. Earnings yield (EY) is found to be the most consistent attribute, whilst the return on equity (ROE) and 3-month prior return (MOM-3) are found to be the least consistent attributes.

Style momentum is assessed using autocorrelation coefficients, partial autocorrelation coefficients and Ljung-Box (1978) Q-statistics. A fair amount of autocorrelation is found to exist, as predicted by Barberis and Shleifer (2003).

Seven forecasting models are constructed, namely the historic mean model (HIST), the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The models are evaluated using six forecasting statistics: the Pearson (1986) correlation between the forecasts and the actual realised payoffs, the direction ratio, the Theil (1958) Inequality Coefficient or U-statistics, the bias, the variance and the covariance. The forecasting models all perform well in terms of forecasting the direction of the payoffs. The MA-6 model is the best performing model in terms of forecast accuracy, whilst the HIST model is the worst performing. The moving average models tend to capture more of the actual variation in the time series and have less structural bias and systematic error than the HIST and exponential smoothing models.

The ability to time styles can lead to improvements in style-based investment strategies. Characteristics which are insignificant in cross-sectional univariate regression tests (as in chapter 6) may even produce significant payoffs if timed correctly. However, the intention of this chapter is purely to assess whether the performance of significant attributes can be improved through the use of various timing models. The seven forecasting models, whilst forecasting direction fairly accurately, perform moderately in terms of forecasting payoff magnitude and have large associated correlation standard deviations and therefore should only really be used as direction forecasters.

-8-

Seasonality in Monthly Style Payoffs

"Seasonality is usually manifested in a significantly large mean return at the turn of the tax year. For most countries this large return occurs in January."

-Gultekin and Gultekin (1983, p.480)

8.1. Introduction

This chapter tests for the presence of seasonality in the monthly payoffs to the sector-specific attributes which are significant in the in-sample period, the out-sample period or both.

The January effect is well documented in international literature, with most authors suggesting that the abnormal returns are the result of tax-loss-selling at the end of the financial year, in December. The January effect is often associated with style anomalies such as the size effect and the earnings yield effect; the literature indicates that style anomalies tend to pay off considerably more in the month of January. Other seasonal months are also identified in the literature, including April and December and again tax-loss selling is the dominant explanation. To this end the months of January, March, April, June, July and December are all excluded, individually and in combination, to assess the presence of seasonality which coincides with the January, April and July financial year ends. These three months are the most common year ends for the countries under consideration and if tax-loss selling occurs, then abnormally low returns would be expected in March, June and December and abnormally high returns would be expected in January, April and July.

In testing for seasonality, three objectives are set: (1) to test whether the significant in-sample and out-sample attributes remain significant after excluding various combinations of the months given above, (2) to test for seasonality in the payoffs to the significant attributes and (3) to identify the months in which the payoffs to any given attribute are significantly higher or lower than normal.

Section 8.2 describes the data and methodology, whilst section 8.3 presents the empirical results and section 8.4 summarises and concludes.

8.2. Data and Methodology

The data employed in this chapter is the time series of payoffs to the attributes which are significant in the in-sample period, the out-sample period or both. To eliminate the effects of look-ahead bias, the forward returns (returns at time $t+1$) and not the ordinary returns (returns at time t) were regressed on each of the attributes in chapter 6. As a result, the attribute payoffs at time t are actually the payoffs that occur at time $t+1$. For the purpose of this chapter, the data set is re-labelled to take account of the lag, by moving all the payoffs one month forward.

As a precursor to the three formalised tests, descriptive statistics are provided in the form of mean of mean and mean of median bar charts, by calendar month for the significant attributes.

8.2.1 T-tests for Seasonality by Exclusion

The aim of this section to assess whether or not attributes, which were previously significant, remain significant after the exclusion of the payoffs in various calendar months. Since some of the attributes are significant in one sample period but not significant over the entire sample period, they are excluded (shown in grey) for the purpose of this analysis. The methodology follows that of Michaud (1999), who identifies significant attributes by subjecting the mean attribute payoffs to Student's (1908) t-test (referred to as the 't-test' for the remainder of this chapter), as in chapter 6 of this study, and then excludes payoffs in the month of January and re-tests the mean attribute payoffs to check if they retain their significance.

In this study, Michaud's (1999) methodology is extended to test for seasonality in not only January but March, April, June, July and December and all possible combinations of the six calendar months. Every month and combination of months is excluded and t-statistics are calculated for mean attribute payoffs in each case. The t-statistics are then tested for significance using the appropriate t-distribution. It is recognised that as the sample size changes with the exclusion of various calendar months and combinations there of, the critical t-statistics also vary. Strictly speaking, direct comparison between the t-statistics cannot be made but it should be noted that the variation in the critical t-statistics is very small (range from 1.978 to 1.997, see appendix E.3 for details).

8.2.2 Nonparametric and Parametric Tests for Seasonality

Two techniques are used to test for the presence of seasonality in the attribute payoffs. The first method is the Kruskal-Wallis (1952) H-test (referred to as the 'H-test' for the remainder of this chapter), which is a nonparametric method and thus has the advantages of not requiring normally distributed data or data groups with similar variances but the disadvantage of being a statistically weaker test than the parametric equivalent, which is the second method, the Analysis of Variance (ANOVA). The ANOVA requires, among others, the assumption of normality in the data, but according to van den Honert (1999), the ANOVA is robust in the presence of non-normality and in its presence the results are still are approximately true.

The H-test tests the null hypothesis that the populations, from which the data samples are drawn, have identical distributions. However, the test is also sensitive to differences in population means and can thus be applied, in the context of this study, to test if any of the mean attribute payoffs for each calendar month are significantly different to the others. Significant H-statistics allow rejection of the null hypothesis that the mean payoffs to each attribute are equal across all the calendar months and confirm the presence of seasonality in the attribute payoffs.

In order to apply the H-test, Conover (1971) states that the following assumptions must be satisfied: (1) all samples must be random samples from their respective populations, (2) the various samples must be mutually independent, (3) all the random variables must be continuous, (4) the measurement scale must be at least ordinal[2], and (5) the population distribution functions of the groups (calendar months in this study) must be identical, except for a possible difference in the population medians.

In order to calculate the H-statistics, the monthly payoffs to each significant in-sample and out-sample attribute are first ranked, with the highest payoff receiving the highest ranking and the lowest payoff, the lowest ranking. The payoffs to each attribute are then grouped according to calendar month and subjected to the H-test:

[2] An ordinal measurement scale allows for objects in one category to be thought of as being in some sense 'less than' or 'greater than' objects in another category. Equivalently, the data can be said to have direction and can be ranked accordingly.

$$H = \frac{12}{N(N+1)}\left[\sum_{m=1}^{r}\frac{R_m^2}{n_m}\right] - 3(N+1) \tag{8.1}$$

Where N is the total number of payoffs in the data set

R_m is the sum of the ranks in month m

n_m is the number of payoffs in the data set for calendar month m

r is the number of calendar months under consideration

Under the null hypothesis, the H-statistic is approximately χ^2-distributed with r-1 degrees of freedom (see van den Honert, 1999) and thus the null hypothesis may be rejected if the H-statistic exceeds the $\chi^2{}_{r-1,1-\alpha}$ critical value, where α is the chosen level of significance. It should be noted that if the null hypothesis is rejected, it merely means that seasonality does exist in the data and does not indicate which months are causing the seasonality. In order to identify these months, parametric Scheffé (1953) contrasts are employed (described in the following section).

The ANOVA is a parametric test which compares the variance within the groups under consideration to the variance between the groups. In the context of this study, the groups are the calendar months and hence the test can be used to identify seasonality in the data. Under the null hypothesis, the population means of the payoffs for each calendar month are identical across the samples and the samples are drawn from the same population. The F-statistic is calculated as follows:

$$F = \frac{MSTR}{MSE} \tag{8.2}$$

Where

$$MSTR = \frac{\sum_{m=1}^{12} n_m(\bar{\lambda}_m - \bar{\lambda})^2}{12-1} \tag{8.3}$$

Where

$$MSE = \frac{\sum_{m=1}^{r}\sum_{i=1}^{n_m}(\lambda_{i,m} - \bar{\lambda}_m)^2}{N-r} \tag{8.4}$$

Where $\overline{\lambda}_m$ is the mean payoff in month m

$\overline{\lambda}$ is the mean payoff for the entire sample

n_m is the number of payoffs in the data set for calendar month m

$\lambda_{i,m}$ is the ith payoff for calendar month m

N is the total number of payoffs in the data set

r is the number of calendar months under consideration

The F-statistic follows an F-distribution, where the numerator has r-1 degrees of freedom and the denominator has N-r degrees of freedom. The null hypothesis is rejected if the variation between the calendar months (given by the MSTR) is significantly larger than the variation within the calendar months (given by the MSE). In such a case the F-statistic exceeds the $F_{r-1,N-r,1-\alpha}$ critical value, where α is the chosen level of significance. Once again it should be noted that like the H-statistic, the ANOVA does not pin-point the calendar months responsible for the seasonality; Scheffé (1953) contrasts serve this purpose and are described in the following section.

Two points of concern are raised with regards, firstly the ANOVA and secondly both the H-test and ANOVA.

The Statsoft Inc. Electronic textbook points out that the ANOVA is sensitive to the influence of outliers and that they can result in rejection of the null hypothesis and, in the context of this study, the false conclusion that seasonality is present in the data. Consider the case where all the calendar months exhibit similar means and variances except for one month which has a significantly higher and mean and variance because of outliers. In such a case the F-statistic will lead to false rejection of the null hypothesis. Ideally, rejection of the null hypothesis is only desired when the mean of a particular calendar month is significantly different to the other months, but the with-in calendar month variance is similar across all months. Outliers should not have a big influence on the data because of the double winsorisation process which was performed on the data (see sections 4.2.2.1 and 4.3.2.1) but as a precautionary measure the Pearson (1896) correlations (referred to as the 'correlation' for the rest of this chapter) between the with-in calendar month means and the with-in calendar month variances are calculated. Attributes which exhibit high correlations between the means and variances could be unduly influenced by outliers and lead to false rejection of the null hypothesis and as such should be treated with care.

The second point of concern is that both the H-test and the ANOVA assume independence within each calendar month and between each calendar month. Whilst within calendar month independence has not been assessed in this study, between calendar month independence was assessed through the autocorrelation, partial autocorrelation and Ljung-Box Q-statistics of chapter 7. A fair amount of autocorrelation was found to exist at some lags for certain attributes and this will be considered when assessing the results in this chapter.

8.2.3 Contrast Tests for Seasonality in Specific Months

In order to identify the months which cause the seasonality in the attribute payoffs, Scheffés (1953) S-method of multiple comparisons is employed. The S-method is a parametric technique, which is robust in the presence of non-normality and allows for every possible contrast to be tested. A disadvantage of the S-method is that it leads to longer confidence intervals than other multiple comparison techniques, such as Tukey's T-method and the Bonferroni multiple t-method. Despite this drawback, it is still the most appropriate technique in that Tukey's T-method requires strict normality in the data and the Bonferroni multiple t-method requires a small number of pre-specified contrasts of interest.

Scheffés (1953) S-method involves constructing 'contrasts' between the mean attribute payoffs for each calendar month, where a contrast is defined as the absolute difference between the two means. The contrasts are then compared to a critical S-statistic which is calculated as follows:

$$S^{\alpha} = \sigma\left[\sqrt{(r-1)F^{\alpha}_{r-1;N-r}}\right] \tag{8.5}$$

Where

$$\sigma = \sqrt{\left[\frac{1}{n_p} + \frac{1}{n_q}\right] MSE} \tag{8.6}$$

Where $F_{r-1,N-r,1-\alpha}$ is the critical F-statistic with r-1 and N-r degrees of freedom at a chosen α level of significance

$n_{p/q}$ is the number of payoffs in the two calendar months p and q under consideration

If the contrasts exceed the critical S-statistic, then the two calendar months can be said to have significantly different payoffs and thus exhibit seasonality.

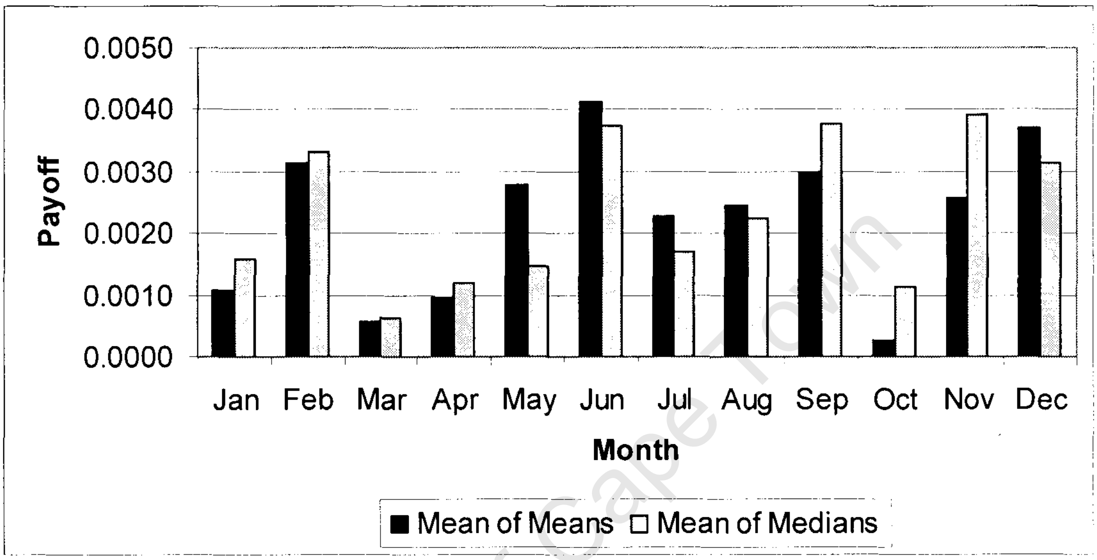
8.3. Empirical Results

Figure 8.1 displays the mean of mean and mean of median payoffs by calendar month averaging across those attributes which are significant in either the in-sample period, the out-sample period or both. The means of means are displayed in black and the means of medians in grey.

The descriptive statistics reveal some form of apparent seasonality in the data. In contrast to the general literature (see Rozeff and Kinney, 1976, Cook and Rozeff, 1984, Jaffe, Keim and Westerfield, 1989) the month of January does not seem to produce higher than average monthly payoffs. If anything it appears to produce slightly lower payoffs than most of the other calendar months. Similarly, April, which is also identified in the literature for exhibiting similar seasonal behaviour (see Reinganum and Shapiro, 1987, Clare, Psaradakis and Thomas, 1995), again seems to produce lower payoffs than the other calendar months. The lowest monthly payoffs are found in October and March, whilst the highest monthly payoffs are found in June, December, September and November. These findings seem to contradict the 'sell in May and go away' effect proposed by Bouman and Jacobsen (2002) but the December seasonal finds support from Clare, Psaradakis and Thomas (1995) and Priestly (1997).

Figure 8.1: Monthly Mean of Mean and Mean of Median Payoffs

The figure displays the mean of mean and mean of median payoffs for those attributes which are significant over the entire sample period from 31 January 1995 to 31 December 2005. The means are displayed by calendar month, averaging across the attributes. Means of means are displayed in black, whilst means of medians are displayed in light grey. The greater the difference between the means / medians across the months, the more seasonality is present in the payoffs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. The data was obtained from Datastream International at the University of Cape Town.



Appendix E.1 displays by calendar month, the mean payoffs to the significant attributes, whilst appendix E.2 displays the equivalent median payoffs.

8.3.1 T-tests for Seasonality by Exclusion

Table 8.1 provides a count of the number of cases of insignificance in formerly significant attributes after exclusion of the given calendar months. The attributes under consideration are those which are significant at the 5% level of significance over the entire sample period. The attributes displayed in grey are those which are significant in either the in-sample period or the out-sample period but not over the whole period. These attributes are excluded for the purpose of this test because the test assumes that the attributes are significant to start with and then counts the number of cases of insignificance after excluding each calendar month. If the attribute is insignificant to start with, then the test is nonsensical. Each calendar month is excluded by itself and in combination with all the other five months under consideration. There are a total of 63 exclusions which can be made but only 32 of the 63 possible exclusions exclude a particular calendar month. For example, of the

63 exclusions made, only 32 exclude January and for the case of 6-month growth in earnings, to price (E-6P), 14 of those cases result in insignificance of the previously significant average payoff.

6-month growth in earnings, to price (E-6P), 1-month (MOM-1), 3-month (MOM-3) and 18-month (MOM-18) prior return all seem to display seasonality in the payoffs in that they become insignificant after the exclusion of various combinations of the six chosen calendar months. In agreement with the descriptive statistics of the previous section, June seems to be produce the largest monthly seasonal since it is responsible for the largest number of changes in significance. December produces the next largest seasonal and March is responsible for the least number of changes in significance, indicating that the payoffs are generally low in this month. The number of changes in significance for the other months under consideration tends to vary between attributes. It should be noted that changes in significance of the t-statistics from significant to insignificant after the exclusion of a given month (or combination of months) indicate that that month(s) contributed a disproportionately large amount to the average overall payoff to the attribute.

Table 8.1: Insignificance of Attributes because of Month Exclusion

The table shows the number of cases of insignificance in the attributes which were previously significant in either the in-sample period, out-sample period or both, owing to exclusion of the given month. The attributes shown in grey are not significant at the 5% level over the entire sample and are therefore disregarded for the purpose of this analysis. All possible combinations of the six months are excluded resulting in a total of 63 exclusion combinations. However, each month is only excluded in 32 of the 63 combinations. The greater the number of cases of insignificance across the months, the more seasonality affects the given attribute. The greater the number of insignificant cases in a given month, the greater the positive payoff to the attribute in that month. Attributes with suspected seasonality are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the non-grey attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test over the entire sample period and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

		Excluded Month					
Style Group	**Attribute**	**Jan**	**Mar**	**Apr**	**Jun**	**Jul**	**Dec**
Value	BP	30	32	32	30	32	28
	CP	0	0	0	0	0	0
	DY	0	0	0	0	0	0
	EY	0	0	0	0	0	0
Growth	**C-6P**	1	2	2	2	2	2
	C-12P	0	0	0	0	0	0
	C-24P	0	0	0	0	0	0
	CB	0	0	0	0	0	0
	D-12P	0	0	0	0	0	0
	D-24P	0	0	0	0	0	0
	E-6P	**14**	**6**	**20**	**22**	**18**	**20**
	E-12P	20	17	20	31	25	24
	E-24P	8	9	0	12	14	14
	PO	0	0	0	0	0	0
	ROE	0	0	0	0	0	0
Momentum	**MOM-1**	**19**	**20**	**23**	**31**	**23**	**28**
	MOM-3	**9**	**8**	**8**	**16**	**10**	**18**
	MOM-6	1	1	0	1	1	1
	MOM-12	0	0	0	0	0	0
	MOM-18	**13**	**10**	**6**	**20**	**16**	**20**

Appendix E.3 displays the t-statistics for each significant attribute after the exclusion of all possible combinations of the six calendar months given above. The appendix also gives the critical t-statistics for each case.

8.3.2 Nonparametric and Parametric Tests for Seasonality

Table 8.2 displays the results of the H-tests and the ANOVA tests on the attributes which are significant over the in-sample period, the out-sample period or both.

The only attribute which produces significant results at the 5% significance level is 24-month growth in earnings, to price (E-24P). For both tests the null hypothesis of identical distributions in the populations from which the samples are drawn is rejected suggesting that E-24P exhibits seasonality in its payoffs. Interestingly, none of the four attributes identified in the previous section seem to exhibit seasonality when tested with the H-test and the ANOVA.

Table 8.2: H & F-statistics for Significant Attributes

The table shows the Kruskal-Wallis (1952) H-statistics and the ANOVA F-statistics for the significant attributes. In this study, the H and F statistics test the alternative hypothesis that the payoffs are seasonal, with the H-statistics following a chi-squared distribution and the F-statistics following an F distribution. Statistics which are significant at the 5% level are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Kruskal-Wallis H-statistic	ANOVA F-statistic
Value	**BP**	6.594	0.471
	CP	7.854	0.657
	DY	8.364	0.839
	EY	10.418	0.842
Growth	**C-6P**	16.977	1.479
	C-12P	9.378	1.171
	C-24P	10.159	0.763
	CB	9.491	0.530
	D-12P	10.486	0.844
	D-24P	9.640	0.640
	E-6P	9.885	0.938
	E-12P	15.023	1.278
	E-24P	**22.796**	**1.969**
	PO	13.004	1.235
	ROE	18.652	1.827
Momentum	**MOM-1**	12.212	1.086
	MOM-3	12.455	1.052
	MOM-6	10.548	0.695
	MOM-12	10.506	0.906
	MOM-18	15.010	1.465

Appendix E.4 displays the correlations between the within calendar month means and standard deviations. Only 18-month prior return (MOM-18) is found to have significant correlation between the means and standard deviations, which is not a concern as MOM-18 does not exhibit seasonality in the ANOVA test. As for the independence assumption of both the H-test and ANOVA, only E-24P exhibits seasonality under these tests and exhibits little autocorrelation in the tests of chapter 7.

8.3.3 Contrast Tests for Seasonality in Specific Months

The results of the Scheffé (1953) contrasts are displayed in appendix E.5. Scheffé's S-method compares the absolute difference between the mean payoffs in two calendar months for a given attribute to a critical S-statistic. None of the contrasts are found to be significant at either the 5% or 10% level of significance and as such the S-method is unable to identify the months responsible for the limited seasonality found in the previous tests.

8.4. Summary and Conclusion

Seasonality is investigated so to uncover any underlying relationship with style anomalies in worldwide sector indices. Descriptive statistics are presented by calendar month and four different tests are conducted in order to test for the presence of seasonality and identify the calendar months causing it.

The descriptive statistics suggest that payoffs to the sector-specific attributes under consideration are higher in June, December, September and November and lower in October and March. This contradicts the general literature which tends to suggest that seasonal effects coincide with tax-loss selling at the tax-year end and that there is period of lower returns between May and October, referred to as the 'sell in May and go away' effect.

The t-tests by exclusion follow the methodology of Michaud (1999) but consider not only January but also March, April, June, July and December. The extension is made in order to cater for countries with April and July tax-year ends. If the tax-loss-selling hypothesis holds, then abnormally low payoffs should occur in the month preceding the tax-year end and abnormally high payoffs should occur in the month following. Each one of the six chosen calendar months is excluded by itself and in combination with the other months and the number of cases where the significance of the t-statistic changes is recorded. The results are again surprising in that June and December are found to be responsible for the largest seasonal payoffs whilst March produces the smallest. From an attribute perspective, 6-month growth in earnings, to price (E-6P), 1-month (MOM-1), 3-month (MOM-3) and 18-month (MOM-18) prior return all seem to display seasonality in their payoffs.

The nonparametric Kruskal-Wallis (1952) H-test and the parametric ANOVA are both used to test for seasonality and both identify 24-month growth in earnings, to price (E-24P) as the only attribute with seasonality in its payoffs.

Scheffé's (1953) S-method is employed to identify the months responsible for any of the observed seasonality, but is unable to pinpoint any particular months.

The general lack of agreement between the findings of this study and the literature is best understood in the context of the averaging effect inherent in conducting a worldwide study. The worldwide sector returns are not separated by country and thus if the tax-loss-selling hypothesis holds, the different countries with their different tax-year ends will dilute the overall effects. As such, only effects which are significant on average over all the countries under consideration can be identified. In conclusion, seasonality is not found to have a significant influence on style anomalies in worldwide sector indices and even in the cases where seasonality is identified, the particular months causing the seasonality cannot be pinpointed.

-9-

Multivariate Sector-Specific Attribute Analysis

"Univariate analysis provides limited useful information for forecasting returns in practice ... a variable with significant explanatory power in isolation from other variables may become dominated when combined with other factors ... multiple regression techniques are applied to properly assess historical factor relationships that may be useful in an institutional multifactor framework."

-Michaud (1999, p.11)

9.1. Introduction

This chapter investigates the multivariate relationship between sector-specific attributes and unadjusted sector returns. The attributes under consideration are the thirteen in-sample attributes, which are significant at the 5% level in the univariate regression tests of chapter 6.

Michaud (1999) stresses the need for a multivariate framework so as to assess the performance of individual attributes in the presence of others. The need arises because whilst an attribute may explain a significant portion of the variation in share returns in isolation, "factor interrelationships and factor-return dynamics" (Michaud, 1999, p.11) can result in it being dominated by other attributes in a multifactor model. The aim of this chapter is assess the payoffs to the individual attributes in a controlled multifactor setting and produce a variety of forecasting models in an attempt to arrive at a model which can successfully forecast out-sample returns.

Multivariate cross-sectional OLS regressions are run on a subset of 'control' attributes so as to derive the controlled[3] payoffs to each attribute. Cumulative controlled payoffs to the 'control' attributes are presented for the in-sample period from 31 January 1995 to 31 December 2001 and style timing is assessed over the in-sample period using the techniques employed in chapter 7. Seven forecasting models are

[3] The term 'controlled' refers to the regression coefficient of an independent variable when other independent variables are also included in the regression i.e. the attribute payoff in a multivariate setting. The term is not derived from the use of the so-called subset of 'control' attributes.

presented and assessed, including the trailing historic mean model, three moving average models and three exponential smoothing models. Michaud (1999, p.12) mentions the 'tiger-in-a-cage' principle as a cautionary implication when including attributes in a forecasting model: "increasing the number of variables may increase in-sample explanatory power but may also reduce out-of-sample forecast power." To this end, a stepwise procedure is employed for each forecasting model, over the in-sample period so to arrive at a 'stepwise optimal' forecasting model which is parsimonious and comprehensive in each case.

The set of 'control' attributes, above, includes any attribute which is included in any of the stepwise optimal forecasting models. A set of 'control' forecasting models is derived using the 'control' attributes, so as to allow comparisons to be made between the various forecasting models. Both sets of forecasting models are assessed over the out-sample period from 31 January 2002 to 31 December 2005. Multivariate cross-sectional weighted least squares (WLS) regressions are performed to counter suspected heteroskedasticity in the cross section of returns. The stepwise optimal and 'control' sets of forecasting models are reconstructed to take account of the new WLS regression coefficients and are again assessed over the out-sample period.

Section 9.2 describes the data and methodology, whilst section 9.3 presents the empirical results and section 9.4 summarises and concludes.

9.2. Data and Methodology

9.2.1 Multivariate Cross-Sectional Regressions

Multivariate OLS cross-sectional regressions are conducted over both the in-sample period from 31 January 1995 to 31 December 2001, and the out-sample period from 31 January 2002 to 31 December 2005. Only unadjusted monthly sector returns are considered in this chapter because of the similarity between the results for the unadjusted and risk-adjusted returns in chapter 6. The unadjusted monthly forward returns are regressed on eleven standardised sector-specific attributes, referred to as the 'control' attributes. The returns are winsorised for outliers and further limited in absolute value to 100%, whilst the attributes are winsorised and standardised to a mean of zero and standard deviation of one to enable comparisons to be made between the slopes of the cross-sectional regression coefficients (see sections 4.2.2.1 and 4.2.3.1 for details).

The control attributes are a subset of the thirteen significant in-sample attributes from the univariate regression tests of chapter 6. As well as being significant at the 5% level in the in-sample univariate tests, they are each present in at least one of the stepwise optimal forecasting models derived in section 9.3.3.1 and are used for consistency and comparison throughout the chapter. The control attributes are Cash Earnings per Share to Price (CP), Dividend Yield (DY), 6-month growth in Cash Earnings, to Price (C-6P), 12-month growth in Cash Earnings, to Price (C-12P), Cash Earnings to Book Value (CB), Payout Ratio (PO), Return on Equity (ROE), 1-month prior return (MOM-1), 3-month prior return (MOM-3), 6-month prior return (MOM-6) and 12-month prior return (MOM-12).

The multifactor regression is of the following form:

$$r_{i,t+1} = \gamma_{0,t+1} + \sum_{j=1}^{11} \gamma_{j,t+1} A_{j,t} + \varepsilon_{i,t+1} \tag{9.1}$$

Where $r_{i,t+1}$ is the observed realised return on sector i at time $t+1$

$A_{j,t}$ is the value of attribute j under consideration at time t

$\gamma_{0,t+1}$ is the cross-sectional OLS regression intercept term at time $t+1$

$\gamma_{j,t+1}$ is the cross-sectional OLS regression coefficient of attribute j at time $t+1$

$\varepsilon_{i,t+1}$ is the unexplained residual return on sector i at time $t+1$

9.2.2 Timing the Multivariate Factors

Three consistency measures are used to assess the controlled monthly payoffs to the 'control' attributes from the multifactor regressions. The measures are the same as those used in chapter 7, namely (1) the number of times the payoff is positive (negative) as a percentage of the total number of months, (2) the nonparametric Runs test which compares the number of runs of positive and negative payoffs to that expected in a random sample assuming a normal distribution and (3) the number of changes in payoff direction as a percentage of the total possible number of changes.

The measures are all detailed in section 7.2.1, and thus only a brief recap follows. The first measure can take on values between 0% and 100%. A style which consistently pays off positively will exhibit a ratio closer to 100%, whilst a style which consistently pays off negatively will exhibit a ratio closer to 0%. Significance is determined at the 5% level by the nonparametric Sign Test under the assumption of binomially distributed data.

The second measure is used to clear up ambiguities which arise under the first measure: if the payoff to a particular style is equally likely to be positive or negative, this does not necessarily imply that the style is inconsistent. To be truly inconsistent the style should also exhibit a high frequency of direction *changes*. The Runs test accounts for these changes by comparing the number of runs of positive and negative payoffs to a particular attribute to that which would be expected assuming a normal distribution. If the observed number of runs is less than the lower bound of a constructed critical region then it can be inferred that the attribute payoffs are consistent in direction. If the observed number of runs is greater than the upper bound, it can be inferred that the attribute payoffs systematically switch from positive to negative more frequently than expected in random sample and as such are highly inconsistent.

The third measure, the number of changes in payoff direction as a percentage of the total possible number of direction changes is employed to assess the relative consistency of the significant attributes and for illustrative purposes.

9.2.3 Multivariate Expected Return Forecasting Models

Two sets of forecasting models are constructed, namely the 'stepwise optimal' models and the 'control' models. The attributes used in each set of models are described in sections 9.2.3.1 and 9.2.3.2, respectively. In each set of forecasting models, there are seven models, the mechanics of which are presented in sections 9.2.3.3 to 9.2.3.5. The models use the same forecasting techniques as those used in chapter 7, the details of which can be found in sections 7.2.3.1 to 7.2.3.3. Details of the weighted least squares models which are constructed for both sets of models are given in section 9.2.3.6.

9.2.3.1. Stepwise Optimal Models

The stepwise optimal models are derived through a stepwise procedure which uses the Grinold (1989) Information Coefficient (referred to as either the 'Information

Coefficient' or 'IC' for the remainder of this chapter) as the primary criterion for assessing the models at each step and the Qian and Hua (2004) Information Ratio (referred to as either the 'Information Ratio' or 'IR' for the remainder of this chapter) as the secondary criterion when several attributes yield the same IC. The IC is defined as the Pearson (1896) correlation between the expected return on sector i at time $t+1$ generated by the forecasting model, and the actual realised return on sector i at time $t+1$, notationally:

$$IC = \rho[E(r_{i,t+1}), r_{i,t+1}] \tag{9.2}$$

And

$$E(r_{i,t+1}) = \hat{\gamma}_{0,t+1} + \sum_{j=1}^{n} \hat{\gamma}_{j,t+1} A_{j,t} \tag{9.3}$$

Where $r_{i,t+1}$ is the observed realised return on sector i at time $t+1$

$A_{j,t}$ is the value of attribute j under consideration at time t

$\hat{y}_{0,t+1}$ is the forecast intercept term at time $t+1$

$\hat{y}_{j,t+1}$ is the forecast coefficient of attribute j at time $t+1$

The IR is defined as the ratio of the mean monthly IC to the standard deviation of the monthly ICs, notationally:

$$IR = \frac{\overline{IC}}{\sigma(IC)} \tag{9.4}$$

Where $\overline{IC}$ is the mean monthly IC

$\sigma(IC)$ is the standard deviation of the monthly IC

The attributes which are candidates for inclusion in the forecasting models are the thirteen in-sample attributes which were significant at the 5% level of significance in the univariate cross-sectional regressions of chapter 6. The stepwise procedure is repeated for each of the seven forecasting models described in sections 9.2.3.3 to 9.2.3.5 and progresses as follows:

In the first step, each of the thirteen attributes is individually regressed on the forward returns over the in-sample period so to yield univariate regressions like those of chapter 6. The forecasting model under consideration is then employed to create one-month-ahead forecasts of the regression coefficients. The actual attribute value at time t is then combined with the forecast regression coefficients at time $t+1$ to arrive at a one-month-ahead forecast for the expected return (see equation 9.3 for details). The in-sample mean monthly ICs and IRs are calculated and the attribute which yields the highest mean monthly IC remains in the model.

In the next step, the remaining twelve attributes which were not included in step one are individually included in the model. Once again, the relevant forecasting model is employed to create one-month-ahead forecasts of the regressions coefficients and the ICs and IRs are calculated. If the highest in-sample mean monthly IC is greater than that found in step one, then the attribute which yields the highest in-sample mean monthly IC upon inclusion in the model, remains in the model and the process continues. If the highest in-sample mean monthly IC is less than that found in the first step, the process stops and the model from the previous step is considered to be 'optimal'[4] under the stepwise procedure.

If at any stage, two attributes yield the same in-sample mean monthly ICs (to three decimal places) upon inclusion in the model, the attribute with the highest in-sample IR remains in the model. If the ICs and IRs are both equal (to three decimal places), further decimal places are considered.

The form of the stepwise optimal models is determined by the in-sample mean monthly ICs and IRs, whilst their performance is assessed over the out-sample period using the out-sample mean monthly ICs and IRs.

9.2.3.2. Control Models

The 'control' models include all the attributes which fall into the 'control' subset of attributes. Each 'control' attribute is found in at least one of the stepwise optimal models in the previous section; the 'control' attributes are listed in section 9.2.1. The 'control' models are created to allow for comparisons in forecasting power to be made between the various forecasting models. The in-sample mean monthly ICs and IRs are presented out of interest since they cannot strictly be used to assess the

[4] The term 'optimal' in the context of the *stepwise* procedure refers to the model with the highest mean monthly IC (or IR if several models have the same mean monthly ICs). Other models may exist, which have higher mean monthly ICs but which were not considered because of the limitations of the stepwise procedure. For example, if the more computationally onerous *all subsets* procedure was used then all combinations of the attributes would be considered and a true optimal model could be found in the context of the attributes under consideration.

performance of the models because the 'control' attributes are derived from the attributes used in the in-sample period for the stepwise optimal models and hence possess an element of data mining. The out-sample mean monthly ICs and IRs are presented and used for model comparison.

9.2.3.3. The Trailing Historic Mean Model

The first forecasting model is the trailing historic mean (HIST): the non-inclusive trailing means of the multifactor regression coefficients for each attribute are calculated for every month in the time series and used as one-month-ahead forecasts of the coefficients. The forecast for the second month in the sample is simply the first month in the sample but as the time series advances, the data set gets bigger and so the mean is calculated over more and more observations such that the forecast for the last payoff is the mean of all the previous payoffs.

9.2.3.4. The Moving Average Models

Three trailing moving average (MA) models are constructed, namely the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) models. The MA models are constructed by calculating the non-inclusive 6-month, 12-month and 18-month trailing moving averages of the multifactor regression coefficients, which are then used as forecasts of the coefficients in the following month (see section 7.2.3.2 for details of the model mechanics).

9.2.3.5. The Exponential Smoothing Models

Three exponential smoothing models are constructed to forecast the monthly multifactor regression coefficients, namely the single exponential smoothing (S-EXP) model, the double exponential smoothing (D-EXP) model and the Holt-Winters exponential smoothing (H-W) model. The S-EXP model is most appropriate for time series data with no linear trend, whilst the D-EXP and H-W models are more appropriate for data with such a trend. The D-EXP and H-W models are similar in that they both assume a linear trend, but the D-EXP is a one-parameter model, whilst the H-W model is a two-parameter model and can thus be argued to be less parsimonious than the D-EXP model but more flexible. To avoid placing prejudgements into the forecasts with regards a trend component, all three models are assessed (see section 7.2.3.3 for details of the model mechanics).

9.2.3.6. Weighted Least Squares Models

Weighted least squares (WLS) models are constructed to combat suspected heteroskedasticity in the residuals of the multifactor OLS cross-sectional regressions. Heteroskedasticity is suspected because the cross-section of sector returns comprises different sectors from different countries, which are unlikely to have the same distribution of residuals. If the heteroskedasticity can be modelled then the performance of the forecasting models can be improved and as such both the stepwise optimal models and the 'control' models are reconstructed using the WLS regression coefficient forecasts. The same attributes are used in all cases but new forecasts are made using the WLS regression coefficients and the seven forecasting models.

In WLS regression, a weight series can be used to correct for heteroskedasticity if the weight values are inversely proportional to the standard deviations of the residuals (EViews 3.1 help system). To this end, trailing 12-month rolling standard deviations of the residuals are used as one-month-ahead forecasts of the actual residual standard deviations at time $t+1$, notationally:

$$\hat{\sigma}(\varepsilon_{t+1}) = \sqrt{\frac{1}{11}\sum_{\tau=0}^{11}(\varepsilon_{t-\tau} - \bar{\varepsilon})^2} \tag{9.5}$$

Where $\hat{\sigma}(\varepsilon_{t+1})$ is the one-month-ahead forecast of the residual standard deviation

$\varepsilon_{t-\tau}$ is the lagged residual value at time t-τ

$\bar{\varepsilon}$ is the mean residual value over the 12-month rolling time period

The weight series then comprises the inverses of the one-month-ahead forecasts of the residual standard deviation. It should be noted that whilst the forecasts are based on a 12-month period, they are still proportional to the one-month standard deviation and can thus be used without scaling[5].

[5] "EViews performs weighted least squares by first dividing the weight series by its mean, then multiplying all of the data for each observation by the scaled weight series. The scaling of the weight series is a normalisation that has no effect on the parameter results, but makes the weighted residuals more comparable to the unweighted residuals" (EViews 3.1 help system).

9.3. Empirical Results

9.3.1 Multivariate Cross-Sectional Regressions

Figure 9.1 displays the evolution of the cumulative controlled payoffs to the 'control' attributes used in the multivariate cross-sectional regression procedure. The 'control' attributes are those attributes which are employed in at least one of the stepwise optimal forecasting models. The controlled cumulative payoffs are displayed over the in-sample period, from 31 January to 1995 to 31 December 2001.

As in chapter 6, the cumulative payoffs represent those to an equally-weighted portfolio and not a market-weighted portfolio, since the sector returns are not weighted by market capitalisation.

Dividend yield (DY), 12-month prior return (MOM-12) and 3-month prior return (MOM-3) appear to produce the highest cumulative controlled payoffs over the period whilst the payout ratio (PO) and 1-month prior return (MOM-1) produce the lowest.

Figure 9.1: Cumulative Payoffs to Control Attributes in Multivariate Regressions

The figure displays the cumulative monthly payoffs to the control attributes from the multivariate regression procedure described in section 9.2.1. All the attributes given are used in one or more of the stepwise optimal forecasting models described in section 9.2.3.1. The controlled cumulative payoffs are shown for the in-sample period for 31 January 1995 to 31 December 2001. All the attributes are significant at the 5% level of significance (two-tailed) in the univariate cross-sectional OLS regression tests of chapter 6 over the in-sample period using unadjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.

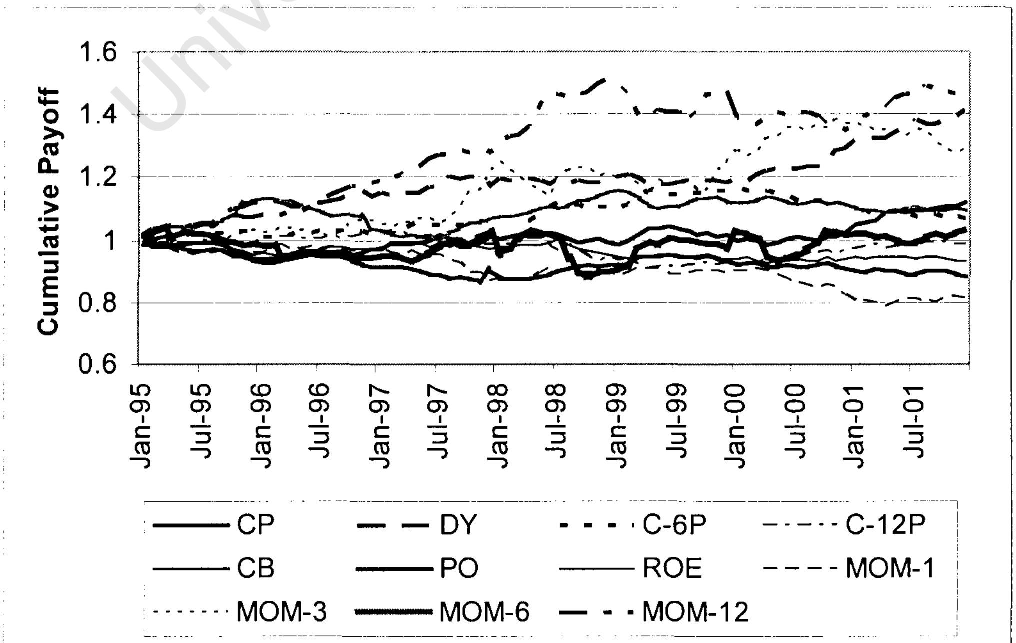


Table 9.1 shows the cumulative controlled payoffs to the 'control' attributes as at the end of the in-sample period. The attributes are displayed in descending order of cumulative controlled payoff. MOM-12 displays the greatest cumulative controlled payoff of 48.75% over the seven year period, with DY coming in a close second at 41.57%. Four of the eleven control attributes payoff negatively over the period with MOM-1 producing the lowest cumulative controlled payoff of -18.72%.

Table 9.1: Cumulative Payoffs to Control Attributes in Multivariate Regressions

The table shows the cumulative payoffs to the control attributes from the multivariate regression procedure described in section 9.2.1. All the attributes given are used in one or more of the stepwise optimal forecasting models described in section 9.2.3.1. The controlled cumulative payoffs are given as at the end of the in-sample period from 31 January 1995 to 31 December 2001. All the attributes are significant at the 5% level of significance (two-tailed) in the univariate cross-sectional OLS regression tests of chapter 6 over the in-sample period using unadjusted returns data. The attributes are displayed in descending order of cumulative payoff. All data was obtained from Datastream International at the University of Cape Town.

Code	Characteristic	Cumulative Payoff
MOM-12	12-month prior return	48.75%
DY	Dividend Yield	41.57%
MOM-3	3-month prior return	28.64%
CP	Cash Earnings per Share to Price	12.05%
CB	Cash Earnings to Book Value	9.65%
C-6P	6-month growth in Cash Earnings, to Price	7.05%
MOM-6	6-month prior return	3.13%
C-12P	12-month growth in Cash Earnings, to Price	-1.47%
ROE	Return on Equity	-6.50%
PO	Payout Ratio	-12.09%
MOM-1	1-month prior return	-18.72%

9.3.2 Timing the Multivariate Factors

Figure 9.2 displays the proportions of positive and negative monthly controlled payoffs to the 'control' attributes over the in-sample period. The percentages of positive payoffs are displayed in black, whilst the percentages of negative payoffs are displayed in light grey. Attributes which consistently pay off positively have ratios close to 100%, whilst ratios which consistently pay off negatively have ratios close to 0%. Attributes with ratios close to 50% could be inconsistent in their payoff direction but the frequency of direction changes must also be considered: true inconsistency also requires a high frequency of direction changes (displayed in figure 9.3).

MOM-12 and DY pay off most consistently in the positive direction at 70.24% and 69.05% of the time, respectively. According to the nonparametric Sign Test these are also the only two attributes which can be said to pay off significantly at the 5% level in the positive direction. PO pays off most consistently in the negative direction at 59.52% of the time and is also the only attribute to pay off significantly at the 5% level in the negative direction according to the nonparametric Sign Test.

Figure 9.2: Consistency in Monthly Style Payoffs for Control Attributes

The figure displays the proportions of positive and negative monthly payoffs to the control attributes. The percentages of positive payoffs are displayed in black, whilst the percentages of negative payoffs are displayed in light grey. Attributes which pay off consistently have ratios closer to 0% or 100%. Dashed lines indicate the 50% level and the 5% significance levels as determined by the nonparametric Sign Test. The controlled monthly payoffs are obtained from the multivariate cross-sectional regression analyses (described in section 9.2.1), which are performed on unadjusted returns data over the in-sample period from 31 January 1995 to 31 December 2001. All the attributes are significant at the 5% level of significance (two-tailed) in the univariate cross-sectional OLS regression tests of chapter 6 over the in-sample period using unadjusted returns data. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

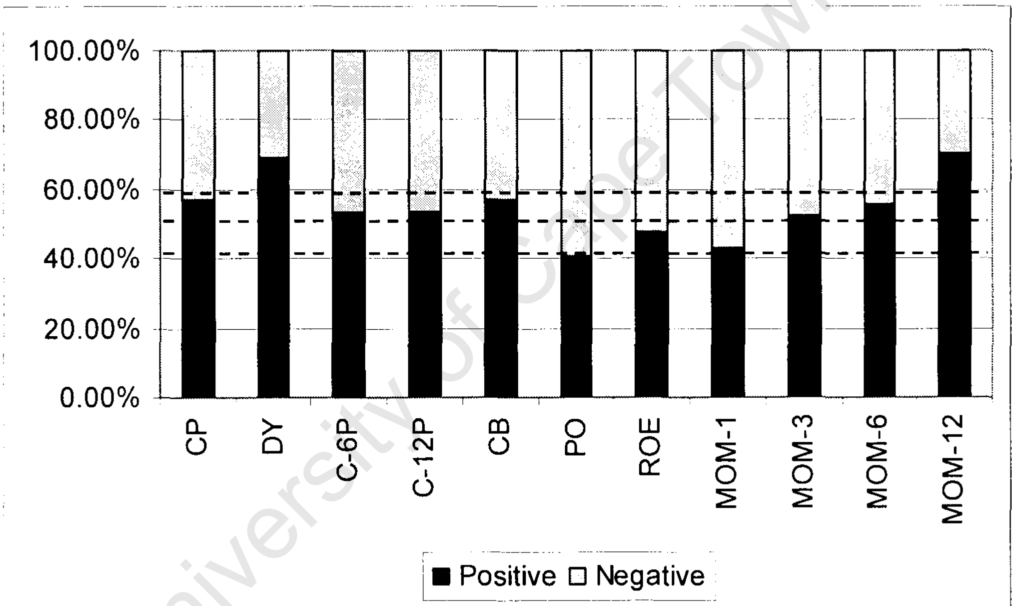


Table 9.2 displays the expected number of runs and the standard deviation of the runs expected in a random sample, assuming a normal distribution of data in the time series. From these two statistics a critical region is constructed at the 95% level of confidence and the upper and lower bounds of the region are displayed along with the actual observed number of runs for each significant attribute. If the observed number of runs falls below the lower bound of the critical region, then the payoffs to the attribute are significantly consistent in their payoff direction and are displayed in bold font.

The Runs test shows that only three attributes are consistent in their payoff direction over the in-sample period, namely dividend yield (DY), 12-month growth in cash earnings, to price (C-12P) and cash earnings to book value (CB).

Table 9.2: Runs Tests for Consistency in Monthly Style Payoff Direction for Control Attributes

The table shows for each control attribute the expected number of runs in a random sample and the associated standard deviation, assuming a normal distribution. In addition, the 95% critical region constructed from the mean and standard deviation and the actual observed number of runs are shown. Where the actual observed number of runs is less than the lower bound of the critical region, the attribute payoffs are significantly consistent in direction at the 5% level of significance and are displayed in bold. The controlled monthly payoffs are obtained from the multivariate cross-sectional regression analyses (described in section 9.2.1), which are performed on unadjusted returns data over the in-sample period from 31 January 1995 to 31 December 2001. All the attributes listed produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Expected Number of Runs	Standard Deviation of Runs	Critical Region (Upper Bound)	Critical Region (Lower Bound)	Number of Runs
Value	**CP**	42.143	4.461	49.480	34.806	38
	DY	36.905	3.886	43.296	30.513	**25**
Growth	**C-6P**	42.786	4.531	50.239	35.332	38
	C-12P	42.786	4.531	50.239	35.332	**33**
	CB	42.143	4.461	49.480	34.806	**34**
	PO	41.476	4.388	48.693	34.259	35
	ROE	42.905	4.544	50.380	35.430	38
Momentum	**MOM-1**	42.143	4.461	49.480	34.806	43
	MOM-3	42.905	4.544	50.380	35.430	42
	MOM-6	42.405	4.490	49.789	35.020	41
	MOM-12	36.119	3.800	42.369	29.869	32

Figure 9.3 displays the frequency of controlled attribute payoff direction changes as a percentage of the total number of possible changes over the in-sample period. The lower the frequency of direction changes the more consistent the style.

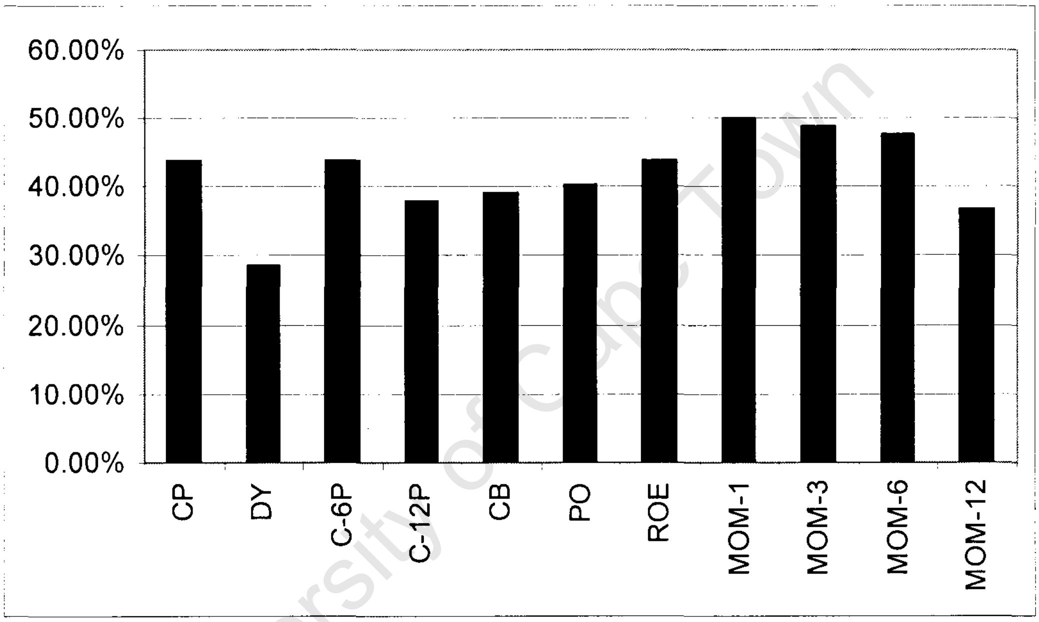
DY, MOM-12, C-12P and CB are shown to be the most consistent in their payoff direction, all changing controlled payoff direction less than 40% of the time. The results are similar to those of the Runs test and whilst this is not surprising given that the two approaches are inherently very similar, the frequency of direction changes graph allows for the relative consistency of the attributes to be assessed, whereas the Runs test only allows for their identification.

DY is by far the most consistent attribute, changing payoff direction only 28.57% of the time, whilst MOM-12 is the second most consistent, changing direction only

36.90% of the time. MOM-1 is the most inconsistent attribute, changing direction 50% of the time.

Figure 9.3: Frequency of Changes in Monthly Style Payoff Direction for Control Attributes

The figure displays the number of times the payoffs changed direction as a percentage of the total possible number of changes. Attributes which are more consistent have lower ratios. The controlled monthly payoffs are obtained from the multivariate cross-sectional regression analyses (described in section 9.2.1), which are performed on unadjusted returns data over the in-sample period from 31 January 1995 to 31 December 2001. All the attributes listed produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.



9.3.3 Multivariate Forecasting Models

9.3.3.1. Stepwise Optimal Models

Table 9.3 shows the mean coefficients from the multivariate cross-sectional regression analyses as well as the mean monthly ICs and IRs for each of the seven stepwise optimal forecasting models. The forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are combined with the actual attribute values for that month to create a forecast of the one-month-ahead forward return. Forecasts are made over both the in-sample and out-sample periods, with the in-sample ICs (and IRs as a secondary criterion) being used to derive the form of the stepwise optimal model and out-sample ICs (and IRs as a secondary criterion) being used to evaluate the performance of the forecasting model.

The double exponential smoothing (D-EXP) model is the best performing model over the in-sample period with a mean monthly IC of 0.091, whilst the 12-month moving average (MA-12) model is the worst performing model over the same period with a mean monthly IC of 0.080.

The 18-month moving average (MA-18) model and the D-EXP model produce the same IC of 0.085 over the out-sample period but the MA-18 model has the higher IR at 0.910 and is thus the best performing model over the out-sample period. As in the in-sample period, the MA-12 model is the worst performing model with an out-sample IC of 0.052.

Five of the seven stepwise optimal models seem to be fairly robust out-of-sample with the mean monthly ICs remaining fairly constant between the in and out-sample periods. The exceptions are the MA-12 model and the single exponential smoothing (S-EXP) model which both experience a large fall in their mean monthly ICs (from 0.080 to 0.052 and from 0.086 to 0.066, respectively).

Despite the consistency in the ICs across the sample periods, none of the models can be said to perform particularly well. None of the models reach Banz's (2004) IC criteria of 0.1, which is the lowest IC a model can have to have exploitable predictive power.

Table 9.3: Regression Coefficients and Forecasting Results for Stepwise Optimal Models

The table shows the mean coefficients from the multivariate cross-sectional regression analyses as well as the mean monthly Information Coefficient (IC) and the mean monthly Information Ratio (IR) for each forecasting model. Seven forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are used in conjunction with the attribute values for that month to create a forecast of the one-month-ahead forward return. The stepwise optimal model is derived in each case by the procedure described in section 9.2.3.1. Forecasts are made over both the in-sample period from 31 January 1995 to 31 December 2001 and the out-sample period from 31 January 2002 to 31 December 2005. The highest in-sample and out-sample ICs and IRs are displayed in bold font. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

	Mean Coefficients												Mean Information Coefficient	Mean Information Ratio
Model	Constant	CP	DY	C-6P	C-12P	CB	PO	ROE	MOM-1	MOM-3	MOM-6	MOM-12		
HIST														
in-sample	0.004		0.005			0.002	-0.002	-0.001			0.002	0.006	0.083	0.536
out-sample	0.018		0.005			0.002	-0.003	-0.002			-0.002	0.005	0.084	0.674
MA-6														
in-sample	0.004	0.002	0.003									0.007	0.085	**0.622**
out-sample	0.017	0.004	0.003									0.004	0.077	0.741
MA-12														
in-sample	0.004		0.003	0.001							0.006		0.080	0.506
out-sample	0.018		0.003	0.001							0.002		0.052	0.539
MA-18														
in-sample	0.004	0.002	0.004				-0.001				0.002	0.006	0.086	0.515
out-sample	0.017	0.003	0.003				-0.001				-0.002	0.005	**0.085**	0.910
S-EXP														
in-sample	0.003		0.003						-0.001	0.002		0.005	0.086	0.611
out-sample	0.017		0.003						-0.001	0.000		0.004	0.066	0.598
D-EXP														
in-sample	0.004	0.002	0.004		0.001		-0.001				0.002	0.006	**0.091**	0.594
out-sample	0.017	0.003	0.003		0.002		-0.001				-0.002	0.005	**0.085**	0.824
H-W														
in-sample	0.004	0.002	0.003									0.007	0.085	0.594
out-sample	0.017	0.004	0.003									0.004	0.083	**1.017**

9.3.3.2. Control Models

Table 9.4 shows the mean coefficients from the multivariate cross-sectional regression analyses as well as the mean monthly ICs and IRs for each of the seven 'control' forecasting models. The forecasting models are used to forecast the one-month-ahead forward returns in a similar fashion to the stepwise optimal models. Forecasts are made over both the in-sample and out-sample periods. The in-sample mean monthly ICs and IRs are displayed out of interest as they cannot strictly be used to compare models since the attributes are derived from the stepwise optimal models over the same period and could thus lead to data mining. The out-sample mean monthly ICs (and IRs as a secondary criterion) are displayed so to evaluate the effectiveness of the various forecasting techniques in a controlled[6] setting.

Interestingly, in a controlled setting the S-EXP model is the best performing model with an out-sample mean monthly IC of 0.094, whilst the 6-month moving average

[6] The term 'controlled' refers to the condition of the same attributes being used in each model such that the only difference between the models is the choice of forecasting technique.

(MA-6) model is the worst performing model with an out-sample mean monthly IC of 0.072.

The ‘control’ models all seem to perform far better out-of-sample than they do in-sample, and in general perform better than the stepwise optimal models out-of-sample. The implication is that whilst the stepwise optimal models can be constructed to perform well in-sample, they are not as robust as the ‘control’ models which tend to perform better out-of-sample. This finding is a direct contradiction to Michaud’s (1999, p.12) ‘tiger-in-a-cage’ principle as it is found that increasing the number of attributes in the multifactor models tends to worsen in-sample performance but makes the models more robust by improving out-sample performance.

Table 9.4: Regression Coefficients and Forecasting Results for Control Models

The table shows the mean coefficients from the multivariate cross-sectional regression analyses as well as the mean monthly Information Coefficient (IC) and the mean monthly Information Ratio (IR) for each forecasting model. Seven forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are used in conjunction with the attribute values for that month to create a forecast of the one-month-ahead forward return. The control models include all the attributes which were included in any of the stepwise optimal models in section 9.3.3.1. Forecasts are made over both the in-sample period from 31 January 1995 to 31 December 2001 and the out-sample period from 31 January 2002 to 31 December 2005. The highest in-sample and out-sample ICs and IRs are displayed in bold font. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

	Mean Coefficients												Mean Information Coefficient	Mean Information Ratio
Model	Constant	CP	DY	C-6P	C-12P	CB	PO	ROE	MOM-1	MOM-3	MOM-6	MOM-12		
HIST														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	0.071	0.468
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	0.091	0.747
MA-6														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	0.061	0.435
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	0.072	0.662
MA-12														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	0.066	0.457
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	0.083	0.808
MA-18														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	0.067	0.433
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	0.086	**0.982**
S-EXP														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	0.074	0.497
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	**0.094**	0.828
D-EXP														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	**0.077**	**0.530**
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	0.079	0.882
H-W														
in-sample	0.004	0.001	0.004	0.001	0.000	0.001	-0.001	-0.001	-0.002	0.003	0.001	0.005	0.069	0.455
out-sample	0.017	0.005	0.003	-0.001	0.002	-0.002	0.000	0.001	-0.001	-0.001	-0.001	0.005	0.084	0.887

9.3.3.3. Weighted Least Squares Stepwise Optimal Models

Table 9.5 shows the mean coefficients from the multivariate WLS cross-sectional regression analyses as well as the mean monthly ICs and IRs for each of the seven stepwise optimal forecasting models. The forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are combined with the actual attribute values for that month to create a forecast of the one-month-ahead forward return in exactly the same way as for the OLS regressions above. The stepwise optimal models are of the same form as for the OLS regressions i.e. they use the same attributes; the difference lies in the values of the constant and attribute coefficients. Forecasts are made over the out-sample period, with the out-sample ICs (and IRs as a secondary criterion) being used to evaluate the performance of the forecasting model.

The D-EXP model is again the best performing model with an out-sample IC of 0.085. The MA-12 model is again the worst performing model with an IC of 0.023. The WLS technique applied in this study does not seem to improve the forecasting ability of the models and in most cases a considerable deterioration in the forecasting power is seen. The implication is that if heteroskedasticity is present in the cross-section of sector returns then it is not of the form captured by the 12-month rolling standard deviation.

Table 9.5: Weighted Least Squares Regression Coefficients and Forecasting Results for Stepwise Optimal Models

The table shows the mean coefficients from the multivariate weighted least squares (WLS) cross-sectional regression analyses as well as the mean monthly Information Coefficient (IC) and the mean monthly Information Ratio (IR) for each forecasting model. Trailing 12-month rolling standard deviations are used to forecast the standard deviations of the residuals in each month. The inverses of the forecast standard deviations are then used as the weight series (see section 9.2.3.6). Seven forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are used in conjunction with the attribute values for that month to create a forecast of the one-month-ahead forward return. The models used possess the same attributes as the stepwise optimal models in section 9.3.3.1 but have different regression coefficients owing to the WLS regression. Forecasts are made over the out-sample period from 31 January 2002 to 31 December 2005. The highest out-sample ICs and IRs are displayed in bold font. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

	Mean Coefficients												Mean Information Coefficient	Mean Information Ratio
Model	Constant	CP	DYC-6	P	C-12P	CB	PO	ROE	MOM-1	MOM-3	MOM-6	MOM-12		
HIST	0.016		0.005			0.000	-0.003	-0.001			-0.003	0.006	0.083	0.716
MA-6	0.016	0.002	0.003									0.005	0.066	0.584
MA-12	0.016		0.003	0.002							0.001		0.023	0.220
MA-18	0.016	0.002	0.004				-0.001				-0.002	0.004	0.068	0.652
S-EXP	0.016		0.002						-0.001	-0.001		0.006	0.055	0.484
D-EXP	0.016	0.002	0.003		0.002		-0.001				-0.003	0.006	**0.085**	0.922
H-W	0.016	0.002	0.003									0.005	0.076	**0.935**

9.3.3.4. Weighted Least Squares Control Models

Table 9.6 shows the mean coefficients from the multivariate WLS cross-sectional regression analyses as well as the mean monthly ICs and IRs for each of the seven 'control' forecasting models. Forecasts are made in the same way as for the stepwise optimal models above and the OLS regression models in the previous section three sections. Every model comprises the same 'control' attributes as in section 9.3.3.2 and again the only difference between the models lies in the values of the constant and attribute coefficients. Forecasts are made over the out-sample period, with the out-sample ICs (and IRs as a secondary criterion) being used to evaluate the performance of the forecasting model.

Surprisingly, in a controlled setting the trailing historic mean (HIST) model is the best performer with an out-sample mean monthly IC of 0.086. The D-EXP model, which was the best performing 'stepwise optimal' model, is the worst performer in a controlled setting with an out-sample IC of 0.053. The WLS technique applied in this study is again shown to be ineffective with the ICs generally deteriorating when WLS regression is used in place of OLS regression.

Table 9.6: Weighted Least Squares Regression Coefficients and Forecasting Results for Control Models

The table shows the mean coefficients from the multivariate weighted least squares (WLS) cross-sectional regression analyses as well as the mean monthly Information Coefficient (IC) and the mean monthly Information Ratio (IR) for each forecasting model. Trailing 12-month rolling standard deviations are used to forecast the standard deviations of the residuals in each month. The inverses of the forecast standard deviations are then used as the weight series (see section 9.2.3.6). Seven forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are used in conjunction with the attribute values for that month to create a forecast of the one-month-ahead forward return. The models include all the control attributes used in the models of section 9.3.3.2 but have different regression coefficients owing to the WLS regression. Forecasts are made over the out-sample period from 31 January 2002 to 31 December 2005. The highest out-sample ICs and IRs are displayed in bold font. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

	Mean Coefficients												Mean Information Coefficient	Mean Information Ratio
Model	Constant	CP	DY	C-6P	C-12P	CB	PO	ROE	MOM-1	MOM-3	MOM-6	MOM-12		
HIST	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	**0.086**	0.670
MA-6	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	0.057	0.557
MA-12	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	0.071	0.645
MA-18	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	0.074	0.812
S-EXP	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	0.084	0.747
D-EXP	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	0.053	0.550
H-W	0.016	0.005	0.002	-0.002	0.003	-0.005	0.000	0.003	0.000	-0.003	0.000	0.006	0.084	**0.836**

9.4. Summary and Conclusion

Multivariate OLS and WLS cross-sectional regression analyses are performed on a subset of 'control' attributes using unadjusted returns in order to investigate how sector-specific attributes relate to the cross section of sector returns in a multifactor setting. The timing and consistency of the controlled payoffs are assessed and forecasting models are derived from the controlled payoffs and evaluated for accuracy.

The multivariate OLS regressions are conducted over the in-sample period using the subset of 'control' attributes which comprises any attributes which are included in any of the seven stepwise optimal forecasting models. 12-month prior return (MOM-12), dividend yield (DY) and 3-month prior return (MOM-3) produce the largest cumulative controlled payoffs over the in-sample period, of 48.75%, 41.57% and 28.64%, respectively. The payout ratio (PO) and 1-month prior return (MOM-1) produce the lowest cumulative controlled payoffs at -12.09% and -18.72%, respectively. The three style timing and consistency measures reveal that DY pays off most consistently in the positive direction, whilst PO pays off most consistently in the negative direction. MOM-12, 12-month growth in cash earnings, to price (C-12P) and cash earnings to book value (CB) are all found to pay off consistently in the positive direction. MOM-1 is shown to be the most inconsistent attribute.

Seven forecasting techniques are used in constructing the forecasting models. The forecasting models are used to forecast the one-month-ahead constant and attribute coefficients which are combined with the actual attribute values for that month to create a forecast of the one-month-ahead forward return.

The stepwise optimal models are constructed using a stepwise procedure, whereby the significant in-sample attributes from chapter 6 are added to the model at each step until a point is reached where the mean monthly IC of the model begins to decrease. The double exponential smoothing (D-EXP) model is the overall best performing model with an in-sample mean monthly IC of 0.091 and an out-sample mean monthly IC of 0.085. The 12-month moving average (MA-12) model is the overall worst performing model with an in-sample mean monthly IC of 0.080 and an out-sample mean monthly IC of 0.052. With the exceptions of the MA-12 model and the single exponential smoothing (S-EXP) model, the models appear to be fairly robust to varying sample periods. The 'control' models all include the same 'control' attributes as explanatory variables and thus allow direct comparison between the forecasting techniques. Surprisingly, the S-EXP model is the best performing model with an out-sample mean monthly IC of 0.094, whilst the 6-month moving average (MA-6) model is the worst performing model with an out-sample mean monthly IC of 0.072. The 'control' models generally perform better than the stepwise optimal models out-of-sample and it is posited that in direct contradiction to Michaud's (1999, p.12) 'tiger-in-a-cage' principle, increasing the number of attributes in the multifactor models tends to make the models more robust out-of-sample.

The WLS regression forecasting models adopt the same attributes as the OLS regression models and are also split into 'stepwise optimal' and 'control' models. They are however re-evaluated using WLS regression constants and coefficients. The weight series applied is the inverse of the rolling 12-month residual standard deviation. WLS does not improve the forecasting ability of any of the models and in most cases there is a considerable deterioration in forecasting accuracy. The results imply that if heteroskedasticity does exist in the cross-section of sector returns then it is not of the form captured by the 12-month rolling residual standard deviation.

Overall none of the models can be said to perform particularly well as none of them reach Banz's (2004) IC criteria of 0.1, which is the lowest IC a model can have to have exploitable predictive power.

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Summary of Results and Conclusion

"In the end, I think we can hope for a coherent story that (1) relates the cross-sectional properties of expected returns to the variation of expected returns through time, and (2) relates the behaviour of expected returns to the real economy in a rather detailed way. Or we can hope to convince ourselves that no such story is possible."

-Fama (1991, p.1610)

10.1. Introduction

The objectives of this study are laid out in detail in the first chapter. The objectives all relate to sector returns and / or sector-specific attributes in a worldwide setting, in summary they are:

Firstly, to assess which asset-pricing model is most suitable for modelling worldwide sector level returns: the single-index model, the empirically testable ICAPM or the multi-index model.

Secondly, to investigate the cross-sectional relationship between worldwide sector returns and sector-specific attributes both before and after CAPM, ICAPM and APT-based risk adjustment. Furthermore the study aims to investigate whether or not the returns to the sector-specific attributes are robust to varying time periods and remain significant out-of-sample.

Thirdly, to investigate the behaviour of the payoffs to the sector-specific attributes in terms of consistency and timing and ascertain whether or not the payoffs can be predicated.

Fourthly, to investigate seasonality in the attribute payoffs and then isolate seasonal trends.

Finally, to conduct multivariate cross-sectional regression analyses and thereby derive various multivariate forecasting models and assess their accuracy and viability.

Section 10.2 summarises the results in terms of the aforementioned objectives, section 10.3 suggests extensions to the research and section 10.4 concludes.

10.2. Summary of Results

The data set used in this study comprises two parts, firstly the market index and sector level returns, and secondly the sector-specific attribute data. The data is collected monthly over an eleven-year period from 31 January 1995 to 31 December 2005. The time series are split up into two time periods to allow testing for sample specificity: the seven year in-sample period from 31 January 1995 to 31 December 2001 and the four year out-sample period from 31 January 2002 to 31 December 2005. The statistical biases that could affect the data include: look-ahead bias, which is addressed by lagging the independent variables with respect to the dependent variables in all the OLS regression tests of chapters 6 and 9; non-uniformity in the data across the various markets, which is partially addressed by converting all the indices to US Dollars before calculating the returns or performing the OLS regression tests; survivorship bias, which will still affect the results as market and sector indices will comprise only those firms that survive the sample period and data snooping which will still affect the data as some of the attributes have been previously identified whilst others may be construed as having little economic reason for inclusion. Both data sets are adjusted for outliers and influential observations by double winsorisation. The market and sector returns data is further limited to 100% in absolute value, whilst the sector-specific attribute data is standardised to allow comparability of the regression coefficients in chapters 6 and 9.

After cluster analysis and factor analysis, the market indices are found to cluster into two groups, which can be broadly defined as the 'developed markets indices' and the 'emerging markets indices'. The Single-Index model uses the FTSE World Market index to proxy for the theoretical market portfolio and empirically tests the CAPM. The empirical ICAPM extends the Single-Index model including three currency risk premia to empirically test the ICAPM. The Multi-Index model uses the FTSE Developed Market index and the FTSE Emerging Market index to proxy for the factors extracted in the factor analysis and empirically test the two-factor APT model. All three models are found to be marginally significant (mean p-values of the F-statistics between 5% and 10%) but with respect to the first objective, the empirical

ICAPM is the best performing model with the lowest p-value of 0.090 and the highest adjusted-R^2 statistic of 0.255.

In terms of the second objective, thirteen sector-specific attributes are significant at the 5% level in the in-sample period and of these, nine are also significant in the out-sample period, namely cash earnings to book value (CB), cash earnings per share to price (CP), 6 and 12-month growth in cash earnings, to price (C-6P & C-12P), dividend yield (DY), 12 and 24-month growth in dividends, to price (D-12P & D-24P), the payout ratio (PO) and the 12-month prior return (MOM-12). DY and CP fall in the 'value' style group and display positive payoffs of 26.85% and 19.29%, respectively over the in-sample period. C-12P, C-6P, PO, CB, D-12P and D-24P all fall in the 'growth' style group and display positive payoffs from 23.24% for C-12P to 14.64% for D-24P over the in-sample period. MOM-12 is the only 'momentum' attribute common to both sample periods but it displays by far the greatest positive payoff over the in-sample period of 64.66%. The nine attributes are significant across both sample periods and are therefore considered to be robust to sample specificity. After risk adjustment with the Single-Index, empirical ICAPM and Multi-Index models, twenty-one, nineteen and twenty-three attributes respectively, are still found to significant. The value, growth and momentum style effects prevail after risk adjustment and, in fact, more attributes within each group become significant after risk adjustment. The implication is that sector-specific attributes are able to explain the variation in sector returns above and beyond the ability of the three asset-pricing models considered in this study.

With regards the third objective, earnings yield (EY) is found to be the most consistent attribute, whilst the return on equity (ROE) and 3-month prior return (MOM-3) are found to be the least consistent attributes. The autocorrelation coefficients, partial autocorrelation coefficients and Ljung-Box (1978) Q-statistics all show a fair amount of autocorrelation to exist, as predicted by Barberis and Shleifer (2003). Seven forecasting models are constructed, namely the historic mean model (HIST), the 6-month (MA-6), 12-month (MA-12) and 18-month (MA-18) moving average models and the single (S-EXP), double (D-EXP) and Holt-Winters (H-W) exponential smoothing models. The MA-6 model is the best performing model in terms of forecast accuracy, whilst the HIST model is the worst performing. The moving average models tend to capture more of the actual variation in the time series and have less structural bias and systematic error than the historical mean and exponential smoothing models. The seven forecasting models, whilst forecasting direction fairly accurately, perform moderately in terms of forecasting payoff magnitude and have large associated correlation standard deviations and therefore should only really be used as direction forecasters.

In terms of the fourth objective, the descriptive statistics suggest that payoffs are higher in June, December, September and November and lower in October and March. The t-tests by exclusion which follow the methodology of Michaud (1999), show that June and December are responsible for the largest seasonal payoffs whilst March produces the smallest. From an attribute perspective, 6-month growth in earnings, to price (E-6P), 1-month (MOM-1), 3-month (MOM-3) and 18-month (MOM-18) prior return all seem to display seasonality in their payoffs. The nonparametric Kruskal-Wallis (1952) H-test and the parametric ANOVA are both used to test for seasonality and both identify 24-month growth in earnings, to price (E-24P) as the only attribute with seasonality in its payoffs. Scheffé's (1953) S-method is employed to identify the months responsible for any of the observed seasonality, but is unable to pinpoint any particular months. Seasonality is not found to have a significant influence on style anomalies in worldwide sector indices and even in the cases where seasonality is identified the particular months causing the seasonality cannot be pinpointed.

With regards the final objective, multivariate OLS regressions are conducted over the in-sample period using the subset of 'control' attributes which comprises any attributes which are included in any of the seven 'stepwise optimal' forecasting models. 12-month prior return (MOM-12), dividend yield (DY) and 3-month prior return (MOM-3) produce the largest cumulative controlled payoffs over the in-sample period, of 48.75%, 41.57% and 28.64%, respectively. The payout ratio (PO) and 1-month prior return (MOM-1) produce the lowest cumulative controlled payoffs at -12.09% and -18.72%, respectively. The three style timing and consistency measures reveal that DY pays off most consistently in the positive direction, whilst PO pays off most consistently in the negative direction. MOM-12, 12-month growth in cash earnings, to price (C-12P) and cash earnings to book value (CB) are all found to pay off consistently in the positive direction. MOM-1 is shown to be the most inconsistent attribute.

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10.3. Suggested Extensions

In choosing the methodology and data for this study compromises were necessarily made between accuracy and practicality. More specifically, the literature deals with a number of methodological biases, some of which, such as look-ahead bias, infrequent trading bias and outliers have been dealt with or have less influence at a sector level. However, some biases may still persist and have an unquantified effect on the results. Survivorship bias can affect analyses at a firm level by enhancing performance in *ex post* studies and since sector indices comprise the surviving shares, thereby affect sector level analyses. In order to combat survivorship bias a methodology is required which when assessing performance, takes cognisance of so-called 'dead' shares which have de-listed over the period of study. Non uniformity in the data set is another point of concern. Whilst returns have all been calculated in US Dollar terms and the indices under consideration are all constructed by Datastream International, other discrepancies may still persist. Political environments and their associated risk differ dramatically from country to country as do legal constructs, capital mobility, monetary and fiscal policy, market liquidity and currency stability. Accounting for these effects is nothing if not an arduous task, which would have to entail an extensive amount of economic modelling and adjustment to the data set.

Liquidity restrictions and transaction costs are not accounted for in the methodology of this study and Robertson (2002) argues that because of this, the impact of anomalies for practitioners is unknown. In a similar vein, information is costly; however in this study it is assumed throughout the asset-pricing models that it is quickly, cheaply and easily attainable by all market participants. According to Grossman and Stiglitz (1980) market participants are aware that the marginal gain from extra information must be balanced with the marginal expense of obtaining that information and therefore that efficient markets cannot hold. It is hoped that in time enough data will be available to allow accurate modelling of the various costs associated with attaining information on which to trade and then the actual costs of trading.

The failure of the three asset-pricing models to capture the variation in sector returns and the clear existence of anomalous attributes cast doubt on traditional financial theory. The joint hypothesis problem results in an unfavourable situation whereby the failure of the asset-pricing models cannot necessarily be attributed to model misspecification since it could also be the result of an inefficient market or market proxy. Similarly, whilst anomalous attributes may in fact proxy for some, as yet, unidentified risk factor and thus warrant inclusion in traditional asset-pricing models, they have been shown to be unstable with numerous reversals in the effects occurring over different time periods. Further assessment of the incumbent asset-pricing models is surely required, with the hopes of relaxing some of the stringent assumptions on which they are based and ultimately the development of more robust models.

In developing the APT model only market indices were considered for clustering and factor analysis. It is purported that sector returns may be more accurately captured in terms of the industry (International Classification Benchmark level 2 indices) returns under which they fall. Further cluster and factor analysis should be conducted, including not only the market index returns but also the industry index returns so as to find better factors from which to model the sector returns.

In this study sectors from different countries are all lumped together and cross-sectionally tested as one unit. The weakness of this methodology is that it assumes that all sectors respond similarly to a given attribute, when in fact they may not. To rectify this, attributes should be cross-sectionally tested for each sector across all the countries so that sector-specific effects can be identified. Similarly, industries could be subjected to the same cross-sectional testing to identify industry-specific factors. By adopting this approach it is purported that seasonality within individual industries and sectors across different countries could be more profound and identifiable. Furthermore, there is the need to apply more sensitive techniques, such as Fourier analysis, to the data in the hope of pinpointing the attributes and months responsible for the seasonality.

The multifactor models are all constructed using a stepwise procedure which is based on the mean monthly IC of the model at each step. The weakness of this methodology is that it does not consider all the possible combinations of attributes and thus there may be a combination that is not tested which actually achieves a higher mean monthly IC. To remedy this situation, an all subsets procedure could be applied so that every possible combination is tested and a *true* optimal model is found.

The final suggested extension is that of further research into the heteroskedasticity of the cross-section of sector returns. It is clear that the rolling 12-month standard deviation of the residuals was not capable of capturing the heteroskedastic variation in the residuals. Other weighted least squares methods could be applied and may be more effective within individual industries or sectors. Alternatively, other methods could be employed to model the volatility, for example GARCH and EGARCH models.

10.4. Conclusion

The field of asset pricing has developed from mean-variance analysis, to theoretically stringent pricing models such as the CAPM, to more inclusive but more indistinct pricing models such as the APT model and in recent history, to the study of so-called 'anomalous' factors. This study has adopted a fresh perspective by testing for anomalous attributes in sector returns and has hopefully contributed to the literature by including the largest possible sample of countries. In the cluster and factor analyses, market indices cluster into developed and emerging markets indicating a clear benefit to diversification by investing from one type of market into the other. Traditional asset-pricing models do not adequately capture the return-generating process in worldwide sector indices and when used for risk adjustment, make little difference to the anomalies found. An empirical ICAPM model which takes into account foreign currency risk seems to be the most appropriate asset-pricing model. Anomalous attributes are found to exist in three style groups, namely the 'value', 'growth' and 'momentum' groups. Generally, sector-specific attributes suffer from a lack of consistency and seasonality cannot be pin-pointed in any particular calendar months. Multivariate models have little forecasting power but of the seven 'control' models, the single exponential smoothing model is the most effective out-of-sample. Heteroskedasticity may exist in the cross-section of worldwide sector returns but it is not of the form captured by the 12-month rolling standard deviation of the residuals.

"The most pressing field of future endeavour is the development and testing of models of market equilibrium under uncertainty. When the process generating equilibrium expected returns is better understood, ... we will have a more substantial framework for more sophisticated intersecurity tests of market efficiency."

-Fama (1970, p.416)

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Appendix A

Appendix A contains material associated with chapter 4: Data and Descriptive Statistics.

Appendix A.1: Sources of Exchange Rates

All the exchange rates used to convert the various currencies to US Dollars were obtained from Datastream International at the University of Cape Town. Official government exchange rates were used in the conversions except where data was not available. These time periods of unavailability are listed below for the relevant countries along with the substitute exchange rates used.

Country	Time Period	Exchange Rate Source
Cyprus	31/01/1993 - 30/04/1997 31/05/1997 - 31/10/2000	Datastream Constructed Reuters
Luxembourg	31/01/1993 - 30/11/1993 31/12/1993 - 31/12/2005	Morgan Stanley Capital International Reuters

Appendix A.2: Industry Classification Benchmark (ICB) Classifications

The table shows the Industry Classification Benchmark (ICB) classifications. Level 1 comprises the market index for each country whilst level 4 comprises 38 sector indices for each country. The Datastream International mnemonics are also provided.

Level	Name	Code
1	Market	TOTMK
4	Oil & Gas Producers	OILGP
	Oil Equipment, Services & Distribution	OILES
	Chemicals	CHMCL
	Forestry & Paper	FSTPA
	Industrial Metals	INDMT
	Mining	MNING
	Construction & Materials	CNSTM
	Aerospace & Defense	AERSP
	General Industrials	GNIND
	Electronic & Electrical Equipment	ELTNC
	Industrial Engineering	INDEN
	Industrial Transportation	INDTR
	Support Services	SUPSV
	Automobiles & Parts	AUTMB
	Beverages	BEVES
	Food Producers	FOODS
	Household Goods	HHOLD
	Leisure Goods	LEISG
	Personal Goods	PERSG
	Tobacco	TOBAC
	Health Care Equipment & Services	HCEQS
	Pharmaceuticals & Biotechnology	PHARM
	Food & Drug Retailers	FDRGR
	General Retailers	GNRET
	Media	MEDIA
	Travel & Leisure	TRLES
	Fixed Line Telecommunications	TELFL
	Mobile Telecommunications	TELMB
	Electricity	ELECT
	Gas, Water & Multiutilities	GWMUT
	Banks	BANKS
	Nonlife Insurance	NLINS
	Life Insurance	LFINS
	Real Estate	RLEST
	General Financial	GENFI
	Nonequity Investment Instruments	EQINV
	Software & Computer Services	SFTCS
	Technology Hardware & Equipment	TECHD

Appendix A.3: Countries under Consideration

The table shows the countries under consideration in this study. The Datastream country codes are also provided for ease of reference.

Country	Code	Country	Code	Country	Code
Argentina	AR	Greece	GR	Philippines	PH
Australia	AU	Hong Kong	HK	Poland	PO
Austria	OE	Hungary	HN	Portugal	PT
Belgium	BG	India	IN	Russia	RS
Brazil	BR	Indonesia	ID	Singapore	SG
Canada	CN	Ireland	IR	South Africa	SA
Chile	CL	Israel	IS	South Korea	KO
China	CH	Italy	IT	Spain	ES
China A	CA	Japan	JP	Sweden	SD
Columbia	CB	Luxembourg	LX	Switzerland	SW
Cyprus	CP	Malaysia	MY	Taiwan	TA
Czech Republic	CZ	Mexico	MX	Thailand	TH
Denmark	DK	New Zealand	NZ	Turkey	TK
Finland	FN	Netherlands	NL	U.K.	UK
France	FR	Norway	NW	U.S.A.	US
Germany	BD	Peru	PE	Venezuela	VE

Appendix A.4: Data Availability by Sector and Country

The table shows the data availability of the various market and sector indices (ICB levels 1 and 4 respectively) for each country. Data availability is indicated with a tick and totals are also provided in summary.

Level	Name	Code	AR	AU	OE	BG	BR	CN	CL	CH	CA	CB	CP	CZ	DK	FN	FR	BD	GR	HK	HN	IN	ID	IR	IS	IT	JP	LX
1	Market	TOTMK	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Oil & Gas Producers	OILGP	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Oil Equipment, Services & Distribution	OILES	✓	✓	✓			✓		✓	✓	✓		✓			✓						✓			✓	✓	
	Chemicals	CHMCL	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
	Forestry & Paper	FSTPA	✓	✓			✓	✓	✓		✓	✓		✓		✓	✓	✓		✓			✓			✓	✓	
	Industrial Metals	INDMT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓				✓	✓	✓
	Mining	MNING		✓				✓	✓	✓	✓	✓		✓				✓				✓	✓	✓			✓	✓
	Construction & Materials	CNSTM	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Aerospace & Defense	AERSP					✓	✓			✓	✓		✓			✓	✓				✓			✓	✓	✓	
	General Industrials	GNIND	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓
	Electronic & Electrical Equipment	ELTNC	✓		✓	✓	✓	✓			✓		✓		✓	✓	✓	✓		✓		✓			✓	✓	✓	✓
	Industrial Engineering	INDEN	✓		✓	✓		✓		✓	✓				✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	
	Industrial Transportation	INDTR	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓	
	Support Services	SUPSV	✓	✓				✓			✓		✓	✓	✓	✓	✓	✓	✓					✓		✓	✓	✓
	Automobiles & Parts	AUTMB	✓	✓	✓		✓	✓		✓	✓					✓	✓	✓		✓	✓	✓	✓			✓	✓	
	Beverages	BEVES	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓			✓		✓	✓	✓
	Food Producers	FOODS	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Household Goods	HHOLD					✓	✓			✓	✓			✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	
	Leisure Goods	LEISG						✓			✓				✓	✓	✓	✓	✓	✓							✓	
	Personal Goods	PERSG	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
	Tobacco	TOBAC					✓	✓	✓		✓	✓		✓								✓	✓				✓	
	Health Care Equipment & Services	HCEQS		✓		✓	✓	✓	✓						✓		✓	✓						✓		✓	✓	
	Pharmaceuticals & Biotechnology	PHARM	✓	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
	Food & Drug Retailers	FDRGR	✓	✓		✓	✓	✓	✓		✓	✓	✓			✓	✓	✓						✓	✓	✓	✓	
	General Retailers	GNRET		✓		✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
	Media	MEDIA		✓		✓	✓	✓			✓		✓			✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓
	Travel & Leisure	TRLES		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
	Fixed Line Telecommunications	TELFL	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Mobile Telecommunications	TELMB				✓	✓	✓			✓						✓	✓	✓	✓		✓	✓		✓		✓	✓
	Electricity	ELECT	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
	Gas, Water & Multiutilities	GWMUT	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓		✓	✓			✓	✓	
	Banks	BANKS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Nonlife Insurance	NLINS		✓	✓		✓	✓		✓			✓		✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
	Life Insurance	LFINS		✓				✓		✓							✓	✓						✓	✓	✓	✓	
	Real Estate	RLEST	✓	✓	✓	✓	✓	✓		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	General Financial	GENFI	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
	Nonequity Investment Instruments	EQINV		✓		✓		✓					✓				✓	✓			✓	✓			✓			✓
	Software & Computer Services	SFTCS		✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
	Technology Hardware & Equipment	TECHD		✓		✓		✓		✓	✓		✓			✓	✓	✓	✓	✓		✓			✓	✓	✓	
	# of observations / [38]		23	30	20	26	27	38	20	20	33	21	20	18	21	25	36	35	23	27	21	26	21	21	23	33	37	17

Appendix A.4: Data Availability by Sector and Country

-continued.

Level	Name	Code	MY	MX	NZ	NL	NW	PE	PH	PO	PT	RS	SG	SA	KO	ES	SD	SW	TA	TH	TK	UK	US	VE	# OBS / [48]
1	Market	TOTMK	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	48
4	Oil & Gas Producers	OILGP	✓		✓		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	37
	Oil Equipment, Services & Distribution	OILES				✓	✓					✓	✓									✓	✓		18
	Chemicals	CHMCL	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	40
	Forestry & Paper	FSTPA		✓	✓	✓	✓			✓	✓			✓	✓	✓	✓	✓		✓		✓	✓	✓	30
	Industrial Metals	INDMT		✓		✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	37
	Mining	MNING		✓				✓	✓					✓		✓	✓			✓		✓	✓		22
	Construction & Materials	CNSTM	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	45
	Aerospace & Defense	AERSP	✓				✓						✓		✓		✓				✓	✓	✓		19
	General Industrials	GNIND	✓	✓					✓		✓		✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	36
	Electronic & Electrical Equipment	ELTNC	✓			✓				✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓		30
	Industrial Engineering	INDEN	✓		✓	✓	✓	✓			✓		✓		✓	✓	✓	✓	✓			✓	✓		31
	Industrial Transportation	INDTR	✓	✓	✓	✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	38
	Support Services	SUPSV		✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓				✓	✓		28
	Automobiles & Parts	AUTMB	✓	✓	✓	✓				✓		✓			✓	✓		✓	✓	✓	✓	✓	✓		30
	Beverages	BEVES	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	37
	Food Producers	FOODS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	44
	Household Goods	HHOLD		✓	✓	✓	✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		31
	Leisure Goods	LEISG				✓								✓	✓			✓	✓		✓	✓	✓		17
	Personal Goods	PERSG	✓	✓		✓		✓		✓					✓	✓	✓	✓	✓			✓	✓	✓	33
	Tobacco	TOBAC	✓												✓	✓	✓					✓	✓		15
	Health Care Equipment & Services	HCEQS		✓	✓								✓	✓		✓	✓	✓		✓	✓	✓	✓		22
	Pharmaceuticals & Biotechnology	PHARM				✓	✓		✓	✓	✓			✓	✓	✓	✓	✓			✓	✓	✓		33
	Food & Drug Retailers	FDRGR		✓		✓			✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	31
	General Retailers	GNRET	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		38
	Media	MEDIA	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		36
	Travel & Leisure	TRLES	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		41
	Fixed Line Telecommunications	TELFL	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	43
	Mobile Telecommunications	TELMB	✓	✓			✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		29
	Electricity	ELECT	✓		✓		✓	✓	✓	✓	✓	✓			✓	✓		✓		✓		✓	✓	✓	36
	Gas, Water & Multiutilities	GWMUT	✓		✓				✓						✓	✓					✓	✓	✓		26
	Banks	BANKS	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	47
	Nonlife Insurance	NLINS	✓	✓		✓		✓		✓		✓		✓	✓	✓		✓			✓	✓	✓		29
	Life Insurance	LFINS		✓		✓	✓	✓					✓	✓			✓	✓				✓	✓		19
	Real Estate	RLEST	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	42
	General Financial	GENFI	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	41
	Nonequity Investment Instruments	EQINV				✓		✓		✓		✓				✓	✓	✓				✓	✓		19
	Software & Computer Services	SFTCS		✓		✓	✓		✓	✓	✓		✓		✓	✓	✓	✓	✓			✓	✓		34
	Technology Hardware & Equipment	TECHD	✓			✓	✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		29
	# of observations / [38]		25	25	20	29	22	17	21	24	20	15	25	28	32	32	29	30	20	22	23	38	38	16	

Appendix A.5: Datastream International Definitions

The Datastream International definitions are given for the raw attributes used to create the sector-specific attributes tested in this study. Whilst, the definitions given relate to individual shares, the sector level equivalents are similar and are constructed (by Datastream) by simply weighting the raw firm-specific attributes by their market capitalisations for each sector. The Datastream code for each attribute is given in brackets.

Book Value per Share **(1308)**

Book value per share is calculated on an issue basis, using that portion of share capital and reserves (excluding preference capital) minus intangibles attributable to the issue, divided by the year-end number of shares in that issue. It is adjusted for subsequent rights and scrip issues.

Cash Earnings per Share **(792)**

Earned for ordinary plus deferred tax and operating provisions, divided by the number of shares in issue.

Dividends per Share **(DPS)**

Dividend per share on a twelve-month rolling basis, taking interim dividends into account.

Dividend Yield **(DY)**

The dividend per share as a percentage of the share price. The underlying dividend is based on an anticipated annual dividend over the following twelve months and for that reason may be calculated on a rolling twelve-month basis, or as the 'indicated' annual amount, or it may be a forecast. The dividend yield is based on gross dividends (including tax credits) where available. Special or once-off dividends are generally excluded.

Earnings per Share **(EPS)**

The latest annualised rate that may reflect the last financial year or be derived from an aggregation of interim period earnings. Where the interim announcements are irregular or lacking in detail, the current earnings per share (EPS) may be a forecast provided by local sources.

Market Value **(MV)**

The share price multiplied by the number of ordinary shares in issue. The amount in issue is updated whenever new tranches of stock are issued or after a capital change. For companies with more than one class of equity capital, the market value is expressed according to the individual issue. Market value is displayed in millions of units of local currency.

Price to Book Ratio **(BP)**

This is the price divided by the book value or net tangible assets per share for the appropriate financial year end, adjusted for capital changes.

Price to Cash Earnings Ratio **(PC)**

Current price divided by cash earnings per share for the appropriate financial year, adjusted for capital changes.

Price to Earnings Ratio **(PE)**

This is the price divided by the earnings rate per share at the required date.

Price Index **(PI)**

The price index expresses the price of an equity as a percentage of its value on the base date, adjusted for capital changes.

Returns Index **(RI)**

Theoretical growth in value of a share holding over a specified period, assuming that dividends are re-invested to purchase additional units of an equity at the closing price applicable on the ex-dividend date.

Turnover by Volume **(VO)**

The number of shares traded for a stock for a particular month. The figure is always expressed in thousands. For stocks which are traded on more than one exchange within the country, default volumes are taken from the primary exchange of that country (note that this is not necessarily the 'home' exchange of the stock).

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

The table shows the availability of market index (ICB Level 1) raw data by country and year. The 'Possible' and 'Theoretical' columns are identical for level 1 and show that for each variable there are twelve possible observations in each year i.e. one observation per month, and that for all eight variables, there are 96 possible observations i.e. twelve observations per year times eight variables. The 'Total' column indicates the number of observations that were actually made across all the variables in each year. The 'Possible' and 'Theoretical' rows are again identical for level 1 and show that the number of possible observations over the thirteen years is 156 i.e. twelve observations per year times thirteen years. The 'Total' row indicates the number of observations that were actually made for each variable over the entire sample period.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Argentina	AR	1993	12	12	12	5	12	12	5	5	12	12	75	96	96
		1994	12	12	12	12	12	12	12	10	12	12	94	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	149	156	156	149	137					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Australia	AU	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	153					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Austria	OE	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	10	12	12	94	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	139					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE		ALL VARIABLES (PI to VO)		
											Possible	Theoretical	Total	Possible	Theoretical
Belgium	BG	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	147					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Brazil	BR	1993	0	0	0	0	0	0	0	0	12	12	0	96	96
		1994	6	0	6	6	6	0	6	0	12	12	30	96	96
		1995	12	0	12	12	12	0	12	0	12	12	60	96	96
		1996	12	0	12	12	12	0	12	0	12	12	60	96	96
		1997	12	0	12	12	12	0	12	0	12	12	60	96	96
		1998	12	0	12	12	12	0	12	0	12	12	60	96	96
		1999	12	0	12	12	12	8	12	11	12	12	79	96	96
		2000	12	0	12	12	12	12	12	11	12	12	83	96	96
		2001	12	0	12	12	12	12	12	11	12	12	83	96	96
		2002	12	0	12	12	12	12	12	10	12	12	82	96	96
		2003	12	0	12	12	12	12	12	11	12	12	83	96	96
		2004	12	0	12	12	12	12	12	11	12	12	83	96	96
		2005	12	0	12	12	12	12	12	11	12	12	83	96	96
Total			138	0	138	138	138	80	138	76					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Canada	CN	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	12	12	12	96	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	155					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Chile	CL	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	146					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
China	CH	1993	6	0	0	6	6	6	6	6	12	12	36	96	96
		1994	12	0	0	12	12	12	12	12	12	12	72	96	96
		1995	12	0	0	12	12	12	12	11	12	12	71	96	96
		1996	12	5	5	12	12	12	12	12	12	12	82	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	12	12	12	96	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			150	113	113	150	150	150	150	145					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
China A	CA	1993	12	8	8	0	12	0	0	12	12	12	52	96	96
		1994	12	12	12	8	12	10	8	12	12	12	86	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	10	12	12	94	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	152	152	140	156	142	140	145					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Columbia	CB	1993	12	12	12	12	12	11	12	11	12	12	94	96	96
		1994	12	12	12	12	12	12	12	9	12	12	93	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	10	12	12	94	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	155	156	138					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Cyprus	CP	1993	12	0	0	12	12	12	12	2	12	12	62	96	96
		1994	12	0	0	12	12	12	12	8	12	12	68	96	96
		1995	12	0	0	12	12	12	12	8	12	12	68	96	96
		1996	12	0	0	12	12	12	12	12	12	12	72	96	96
		1997	12	0	0	12	12	12	12	12	12	12	72	96	96
		1998	12	0	0	12	12	12	12	12	12	12	72	96	96
		1999	12	0	0	12	12	12	12	9	12	12	69	96	96
		2000	12	0	0	12	12	12	12	11	12	12	71	96	96
		2001	12	0	0	12	12	12	12	12	12	12	72	96	96
		2002	12	0	0	12	12	12	12	12	12	12	72	96	96
		2003	12	0	0	12	12	12	12	12	12	12	72	96	96
		2004	12	0	0	12	12	12	12	11	12	12	71	96	96
		2005	12	0	0	12	12	12	12	11	12	12	71	96	96
Total			156	0	0	156	156	156	156	132					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Czech Republic	CZ	1993	2	0	0	0	2	2	2	1	12	12	9	96	96
		1994	12	0	0	12	12	12	12	6	12	12	66	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	10	12	12	94	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			146	132	132	144	146	146	146	129					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Denmark	DK	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	10	12	12	94	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	10	12	12	94	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	140					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Finland	FN	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	10	12	12	94	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	142					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
France	FR	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	149					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Germany	BD	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	144					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Greece	GR	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	148					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Hong Kong	HK	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	148					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Hungary	HN	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	10	12	12	94	96	96
		2002	12	12	12	12	12	12	12	12	12	12	96	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	146					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
India	IN	1993	12	12	12	12	12	12	12	0	12	12	84	96	96
		1994	12	12	12	12	12	12	12	0	12	12	84	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	125					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Indonesia	ID	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	10	12	12	94	96	96
		1995	12	12	12	12	12	12	12	9	12	12	93	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	9	12	12	93	96	96
		1998	12	12	12	12	12	12	12	9	12	12	93	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	9	12	12	93	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	9	12	12	93	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	130					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Ireland	IR	1993	12	12	12	12	12	12	12	0	12	12	84	96	96
		1994	12	12	12	12	12	12	12	0	12	12	84	96	96
		1995	12	12	12	12	12	12	12	0	12	12	84	96	96
		1996	12	12	12	12	12	12	12	0	12	12	84	96	96
		1997	12	12	12	12	12	12	12	0	12	12	84	96	96
		1998	12	12	12	12	12	12	12	0	12	12	84	96	96
		1999	12	12	12	12	12	12	12	0	12	12	84	96	96
		2000	12	12	12	12	12	12	12	3	12	12	87	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	62					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Israel	IS	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	8	12	12	92	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	12	12	12	96	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	146					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Italy	IT	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	148					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Japan	JP	1993	12	12	0	12	12	12	12	12	12	12	84	96	96
		1994	12	12	0	12	12	12	12	12	12	12	84	96	96
		1995	12	12	0	12	12	12	12	12	12	12	84	96	96
		1996	12	12	0	12	12	12	12	11	12	12	83	96	96
		1997	12	12	0	12	12	12	12	11	12	12	83	96	96
		1998	12	12	0	12	12	12	12	11	12	12	83	96	96
		1999	12	12	0	12	12	12	12	11	12	12	83	96	96
		2000	12	12	0	12	12	12	12	12	12	12	84	96	96
		2001	12	12	0	12	12	12	12	10	12	12	82	96	96
		2002	12	12	0	12	12	12	12	11	12	12	83	96	96
		2003	12	12	0	12	12	12	12	11	12	12	83	96	96
		2004	12	12	0	12	12	12	12	11	12	12	83	96	96
		2005	12	12	0	12	12	12	12	11	12	12	83	96	96
Total			156	156	0	156	156	156	156	146					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Luxembourg	LX	1993	12	12	12	12	12	12	12	0	12	12	84	96	96
		1994	12	12	12	12	12	12	12	0	12	12	84	96	96
		1995	12	12	12	12	12	12	12	0	12	12	84	96	96
		1996	12	12	12	12	12	12	12	0	12	12	84	96	96
		1997	12	12	12	12	12	12	12	0	12	12	84	96	96
		1998	12	12	12	12	12	12	12	0	12	12	84	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	78					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Malaysia	MY	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	9	12	12	93	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	10	12	12	94	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	10	12	12	94	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	12	12	12	96	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	139					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Mexico	MX	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	152					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
New Zealand	NZ	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	152					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Netherlands	NL	1993	12	12	12	12	12	12	12	9	12	12	93	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	10	12	12	94	96	96
		1997	12	12	12	12	12	12	12	9	12	12	93	96	96
		1998	12	12	12	12	12	12	12	10	12	12	94	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	10	12	12	94	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	139					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Norway	NW	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	10	12	12	94	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	142					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE		ALL VARIABLES (PI to VO)		
											Possible	Theoretical	Total	Possible	Theoretical
Peru	PE	1993	0	0	0	0	0	0	0	0	12	12	0	96	96
		1994	12	12	12	12	12	12	12	10	12	12	94	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	10	12	12	94	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	10	12	12	94	96	96
		2002	12	12	12	12	12	12	12	9	12	12	93	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			144	144	144	144	144	144	144	127					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Philippines	PH	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	8	12	12	92	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	9	12	12	93	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	10	12	12	94	96	96
		2002	12	12	12	12	12	12	12	9	12	12	93	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	10	12	12	94	96	96
Total			156	156	156	156	156	156	156	132					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Poland	PO	1993	0	0	0	0	0	0	0	0	12	12	0	96	96
		1994	10	10	10	10	10	10	10	5	12	12	75	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			142	142	142	142	142	142	142	134					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Portugal	PT	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	150					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE		ALL VARIABLES (PI to VO)		
											Possible	Theoretical	Total	Possible	Theoretical
Russia	RS	1993	0	0	0	0	0	0	0	0	12	12	0	96	96
		1994	7	0	0	0	7	0	7	0	12	12	21	96	96
		1995	12	4	0	12	12	12	12	1	12	12	65	96	96
		1996	12	12	0	12	12	12	12	8	12	12	80	96	96
		1997	12	12	0	12	12	12	12	12	12	12	84	96	96
		1998	12	12	0	12	12	12	12	12	12	12	84	96	96
		1999	12	12	0	12	12	12	12	12	12	12	84	96	96
		2000	12	12	0	12	12	12	12	12	12	12	84	96	96
		2001	12	12	0	12	12	12	12	10	12	12	82	96	96
		2002	12	12	0	12	12	12	12	12	12	12	84	96	96
		2003	12	12	0	12	12	12	12	11	12	12	83	96	96
		2004	12	12	0	12	12	12	12	12	12	12	84	96	96
		2005	12	12	0	12	12	12	12	12	12	12	84	96	96
Total			139	124	0	132	139	132	139	114					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Singapore	SG	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	151					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
South Africa	SA	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	151					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
South Korea	KO	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	10	12	12	94	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	10	12	12	94	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	141					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Spain	ES	1993	12	12	12	12	12	12	12	12	12	12	96	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	148					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Sweden	SD	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	11	12	12	95	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	10	12	12	94	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	143					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Switzerland	SW	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	11	12	12	95	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	10	12	12	94	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	10	12	12	94	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	143					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Taiwan	TA	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	11	12	12	95	96	96
		1995	12	12	12	12	12	12	12	10	12	12	94	96	96
		1996	12	12	12	12	12	12	12	9	12	12	93	96	96
		1997	12	12	12	12	12	12	12	10	12	12	94	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	10	12	12	94	96	96
		2004	12	12	12	12	12	12	12	12	12	12	96	96	96
		2005	12	12	12	12	12	12	12	11	12	12	95	96	96
Total			156	156	156	156	156	156	156	140					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Thailand	TH	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	9	12	12	93	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	11	12	12	95	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	146					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
Turkey	TK	1993	12	12	12	12	12	12	12	10	12	12	94	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	9	12	12	93	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	10	12	12	94	96	96
		1999	12	12	12	12	12	12	12	9	12	12	93	96	96
		2000	12	12	12	12	12	12	12	11	12	12	95	96	96
		2001	12	12	12	12	12	12	12	11	12	12	95	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	11	12	12	95	96	96
		2004	12	12	12	12	12	12	12	10	12	12	94	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	140					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
U.K.	UK	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	11	12	12	95	96	96
		1998	12	12	12	12	12	12	12	10	12	12	94	96	96
		1999	12	12	12	12	12	12	12	10	12	12	94	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	148					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					
U.S.A.	US	1993	12	12	12	12	12	12	12	11	12	12	95	96	96
		1994	12	12	12	12	12	12	12	12	12	12	96	96	96
		1995	12	12	12	12	12	12	12	12	12	12	96	96	96
		1996	12	12	12	12	12	12	12	12	12	12	96	96	96
		1997	12	12	12	12	12	12	12	12	12	12	96	96	96
		1998	12	12	12	12	12	12	12	12	12	12	96	96	96
		1999	12	12	12	12	12	12	12	11	12	12	95	96	96
		2000	12	12	12	12	12	12	12	12	12	12	96	96	96
		2001	12	12	12	12	12	12	12	12	12	12	96	96	96
		2002	12	12	12	12	12	12	12	11	12	12	95	96	96
		2003	12	12	12	12	12	12	12	12	12	12	96	96	96
		2004	12	12	12	12	12	12	12	11	12	12	95	96	96
		2005	12	12	12	12	12	12	12	12	12	12	96	96	96
Total			156	156	156	156	156	156	156	152					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.6: Market Index (ICB Level 1) Raw Data Availability by Country and Year

-continued.

Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE		ALL VARIABLES (PI to VO)		
											Possible	Theoretical	Total	Possible	Theoretical
Venezuela	VE	1993	12	0	0	12	12	12	12	11	12	12	71	96	96
		1994	12	0	0	12	12	12	12	9	12	12	69	96	96
		1995	12	0	0	12	12	12	12	11	12	12	71	96	96
		1996	12	0	0	12	12	12	12	12	12	12	72	96	96
		1997	12	0	0	12	12	12	12	12	12	12	72	96	96
		1998	12	0	0	12	12	12	12	12	12	12	72	96	96
		1999	12	0	0	12	12	12	12	11	12	12	71	96	96
		2000	12	0	0	12	12	12	12	12	12	12	72	96	96
		2001	12	0	0	12	12	12	12	11	12	12	71	96	96
		2002	12	0	0	12	12	12	12	10	12	12	70	96	96
		2003	12	0	0	12	12	12	12	12	12	12	72	96	96
		2004	12	0	0	12	12	12	12	12	12	12	72	96	96
		2005	12	0	0	12	12	12	12	11	12	12	71	96	96
Total			156	0	0	156	156	156	156	146					
Possible			156	156	156	156	156	156	156	156					
Theoretical			156	156	156	156	156	156	156	156					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

The table shows the availability of sector index (ICB Level 4) raw data by country and year. The 'Possible' column shows the number of observations possible in the year, given the number of sectors for which data is available i.e. number of available sectors times twelve months. The 'Theoretical' column shows that 456 observations could be made if data was available for all 38 sectors i.e. 38 sectors times twelve months. 'Possible' and 'Theoretical' columns are presented for individual variables and for all eight variables, collectively. The 'Total' column indicates the number of observations that were actually made across all the variables in each year. The 'Possible' rows show the number of observations that could have been made for a variable over the entire sample, given the number of sectors available i.e. number of available sectors times twelve months times thirteen years. The 'Theoretical' rows show that 5928 observations could be made if data was available for all 38 sectors over the entire sample i.e. 38 sectors times twelve months times thirteen years. The 'Total' row indicates the number of observations that were actually made for each variable over the entire sample period.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Argentina	AR	1993	162	98	55	92	162	121	94	73	276	456	857	2208	3648
		1994	237	140	78	206	237	166	206	161	276	456	1431	2208	3648
		1995	264	168	84	235	264	221	235	186	276	456	1657	2208	3648
		1996	264	192	96	252	264	251	252	194	276	456	1765	2208	3648
		1997	264	192	96	262	264	252	262	217	276	456	1809	2208	3648
		1998	264	228	96	264	264	252	264	205	276	456	1837	2208	3648
		1999	270	252	99	270	270	258	270	196	276	456	1885	2208	3648
		2000	276	252	120	276	276	264	276	180	276	456	1920	2208	3648
		2001	276	252	120	276	276	267	276	166	276	456	1909	2208	3648
		2002	276	252	120	276	276	276	276	195	276	456	1947	2208	3648
		2003	276	252	120	276	276	276	276	232	276	456	1984	2208	3648
		2004	276	252	120	276	276	276	276	252	276	456	2004	2208	3648
		2005	276	256	120	276	276	276	276	215	276	456	1971	2208	3648
Total			3381	2786	1324	3237	3381	3156	3239	2472					
Possible			3588	3588	3588	3588	3588	3588	3588	3588					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Australia	AU	1993	270	174	210	270	270	282	270	270	360	456	2016	2880	3648
		1994	284	213	249	284	284	296	284	284	360	456	2178	2880	3648
		1995	288	229	264	292	288	300	288	286	360	456	2235	2880	3648
		1996	291	249	273	303	291	303	291	288	360	456	2289	2880	3648
		1997	302	266	300	314	302	314	302	277	360	456	2377	2880	3648
		1998	312	276	312	324	312	324	312	312	360	456	2484	2880	3648
		1999	318	293	318	324	318	324	318	291	360	456	2504	2880	3648
		2000	336	300	330	336	336	328	336	336	360	456	2638	2880	3648
		2001	356	324	348	356	356	341	356	355	360	456	2792	2880	3648
		2002	360	324	348	360	360	352	360	329	360	456	2793	2880	3648
		2003	360	336	360	360	360	360	360	357	360	456	2853	2880	3648
		2004	360	336	360	360	360	360	360	342	360	456	2838	2880	3648
		2005	360	336	360	360	360	360	360	336	360	456	2832	2880	3648
Total			4197	3656	4032	4243	4197	4244	4197	4063					
Possible			4680	4680	4680	4680	4680	4680	4680	4680					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Austria	OE	1993	144	132	144	168	144	156	144	116	240	456	1148	1920	3648
		1994	153	132	153	177	153	165	153	140	240	456	1226	1920	3648
		1995	165	141	165	180	165	168	165	150	240	456	1299	1920	3648
		1996	168	156	171	180	168	168	168	151	240	456	1330	1920	3648
		1997	168	156	180	180	168	168	168	137	240	456	1325	1920	3648
		1998	168	157	180	180	168	168	168	146	240	456	1335	1920	3648
		1999	173	170	182	185	173	168	173	145	240	456	1369	1920	3648
		2000	192	204	206	204	192	170	192	169	240	456	1529	1920	3648
		2001	204	216	216	216	204	180	204	181	240	456	1621	1920	3648
		2002	204	216	216	216	204	185	204	166	240	456	1611	1920	3648
		2003	215	217	217	226	215	193	215	194	240	456	1692	1920	3648
		2004	228	228	228	228	228	213	228	183	240	456	1764	1920	3648
		2005	239	228	228	239	239	228	239	214	240	456	1854	1920	3648
Total			2421	2353	2486	2579	2421	2330	2421	2092					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Belgium	BG	1993	227	192	192	219	227	228	227	130	312	456	1642	2496	3648
		1994	228	192	192	228	228	233	228	147	312	456	1676	2496	3648
		1995	228	192	192	228	228	240	228	209	312	456	1745	2496	3648
		1996	235	199	199	238	235	247	235	203	312	456	1791	2496	3648
		1997	243	219	219	252	243	252	243	200	312	456	1871	2496	3648
		1998	264	241	238	255	264	275	264	238	312	456	2039	2496	3648
		1999	284	282	282	281	284	296	284	254	312	456	2247	2496	3648
		2000	288	288	288	288	288	300	288	265	312	456	2293	2496	3648
		2001	288	288	288	288	288	300	288	264	312	456	2292	2496	3648
		2002	288	288	288	288	288	300	288	260	312	456	2288	2496	3648
		2003	288	288	288	288	288	300	288	283	312	456	2311	2496	3648
		2004	298	298	298	298	298	300	298	296	312	456	2384	2496	3648
		2005	309	300	309	309	309	309	309	309	312	456	2463	2496	3648
Total			3468	3267	3273	3460	3468	3580	3468	3058					
Possible			4056	4056	4056	4056	4056	4056	4056	4056					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Brazil	BR	1993	0	0	0	0	0	12	0	0	324	456	12	2592	3648
		1994	84	0	60	78	84	12	84	5	324	456	407	2592	3648
		1995	170	0	120	158	170	14	170	11	324	456	813	2592	3648
		1996	181	0	132	169	181	24	181	10	324	456	878	2592	3648
		1997	210	0	150	197	210	24	210	18	324	456	1019	2592	3648
		1998	228	0	172	214	228	24	228	16	324	456	1110	2592	3648
		1999	228	0	184	228	228	124	228	181	324	456	1401	2592	3648
		2000	233	0	192	239	233	203	233	193	324	456	1526	2592	3648
		2001	240	0	192	252	240	227	240	193	324	456	1584	2592	3648
		2002	263	0	192	275	263	249	263	197	324	456	1702	2592	3648
		2003	264	0	192	276	264	257	264	221	324	456	1738	2592	3648
		2004	283	0	195	288	283	271	283	240	324	456	1843	2592	3648
		2005	318	0	204	318	318	304	318	277	324	456	2057	2592	3648
Total			2702	0	1985	2692	2702	1745	2702	1562					
Possible			4212	4212	4212	4212	4212	4212	4212	4212					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Canada	CN	1993	444	361	361	444	444	444	444	428	456	456	3370	3648	3648
		1994	444	384	384	444	444	444	444	427	456	456	3415	3648	3648
		1995	444	396	396	444	444	444	444	436	456	456	3448	3648	3648
		1996	447	408	408	447	447	447	447	444	456	456	3495	3648	3648
		1997	456	413	413	456	456	456	456	455	456	456	3561	3648	3648
		1998	456	427	427	456	456	456	456	456	456	456	3590	3648	3648
		1999	456	432	432	456	456	456	456	456	456	456	3600	3648	3648
		2000	456	438	438	456	456	456	456	456	456	456	3612	3648	3648
		2001	456	444	444	456	456	456	456	456	456	456	3624	3648	3648
		2002	456	452	452	456	456	456	456	418	456	456	3602	3648	3648
		2003	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2004	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2005	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
Total			5883	5523	5523	5883	5883	5883	5883	5800					
Possible			5928	5928	5928	5928	5928	5928	5928	5928					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Chile	CL	1993	204	168	168	204	204	204	204	167	240	456	1523	1920	3648
		1994	204	168	168	204	204	204	204	169	240	456	1525	1920	3648
		1995	204	180	180	204	204	204	204	188	240	456	1568	1920	3648
		1996	204	192	192	204	204	204	204	172	240	456	1576	1920	3648
		1997	216	216	216	216	216	204	216	194	240	456	1694	1920	3648
		1998	240	216	228	240	240	208	240	186	240	456	1798	1920	3648
		1999	240	228	240	240	240	230	240	201	240	456	1859	1920	3648
		2000	240	228	240	240	240	240	240	214	240	456	1882	1920	3648
		2001	240	228	240	240	240	240	240	204	240	456	1872	1920	3648
		2002	240	228	240	240	240	240	240	177	240	456	1845	1920	3648
		2003	240	228	240	240	240	240	240	198	240	456	1866	1920	3648
		2004	240	228	240	240	240	240	240	193	240	456	1861	1920	3648
		2005	240	228	240	240	240	240	240	206	240	456	1874	1920	3648
Total			2952	2736	2832	2952	2952	2898	2952	2469					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
China	CH	1993	31	0	0	18	31	24	31	30	240	456	165	1920	3648
		1994	73	0	0	45	73	53	73	70	240	456	387	1920	3648
		1995	91	0	0	73	91	86	91	79	240	456	511	1920	3648
		1996	104	35	35	98	104	96	104	96	240	456	672	1920	3648
		1997	126	93	93	115	126	105	126	112	240	456	896	1920	3648
		1998	144	117	117	133	144	132	144	132	240	456	1063	1920	3648
		1999	144	120	120	144	144	144	144	127	240	456	1087	1920	3648
		2000	144	129	129	144	144	144	144	138	240	456	1116	1920	3648
		2001	155	143	143	144	155	153	155	143	240	456	1191	1920	3648
		2002	160	148	148	158	160	156	160	151	240	456	1241	1920	3648
		2003	187	175	175	187	187	174	187	171	240	456	1443	1920	3648
		2004	216	215	205	216	216	205	216	216	240	456	1705	1920	3648
		2005	224	228	224	224	224	217	224	224	240	456	1789	1920	3648
Total			1799	1403	1389	1699	1799	1689	1799	1689					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
China A	CA	1993	132	69	61	109	132	20	66	127	396	456	716	3168	3648
		1994	229	151	151	225	229	190	190	226	396	456	1591	3168	3648
		1995	240	228	228	276	240	238	240	219	396	456	1909	3168	3648
		1996	250	228	228	285	250	242	250	206	396	456	1939	3168	3648
		1997	297	228	228	300	297	280	290	272	396	456	2192	3168	3648
		1998	328	234	234	312	328	322	320	302	396	456	2380	3168	3648
		1999	348	374	374	336	348	348	348	290	396	456	2766	3168	3648
		2000	350	384	384	338	350	349	350	317	396	456	2822	3168	3648
		2001	372	384	384	370	372	370	372	339	396	456	2963	3168	3648
		2002	380	384	384	380	380	377	380	346	396	456	3011	3168	3648
		2003	384	384	384	384	384	384	384	352	396	456	3040	3168	3648
		2004	389	389	389	389	389	384	389	387	396	456	3105	3168	3648
		2005	396	396	396	396	396	394	396	393	396	456	3163	3168	3648
Total			4095	3833	3825	4100	4095	3898	3975	3776					
Possible			5148	5148	5148	5148	5148	5148	5148	5148					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Columbia	CB	1993	180	132	144	146	180	151	158	62	252	456	1153	2016	3648
		1994	185	132	144	181	185	180	183	73	252	456	1263	2016	3648
		1995	192	146	158	192	192	180	192	78	252	456	1330	2016	3648
		1996	192	168	180	192	192	180	192	71	252	456	1367	2016	3648
		1997	192	168	180	192	192	180	192	76	252	456	1372	2016	3648
		1998	192	180	192	192	192	180	192	79	252	456	1399	2016	3648
		1999	192	180	192	192	192	190	192	75	252	456	1405	2016	3648
		2000	208	180	210	208	208	218	208	76	252	456	1516	2016	3648
		2001	224	180	216	224	224	231	224	92	252	456	1615	2016	3648
		2002	240	192	216	240	240	240	240	112	252	456	1720	2016	3648
		2003	244	202	226	244	244	234	244	112	252	456	1750	2016	3648
		2004	240	204	228	240	240	228	240	128	252	456	1748	2016	3648
		2005	240	204	228	240	240	228	240	123	252	456	1743	2016	3648
Total			2721	2268	2514	2683	2721	2620	2697	1157					
Possible			3276	3276	3276	3276	3276	3276	3276	3276					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Cyprus	CP	1993	96	0	0	204	96	72	96	2	240	456	566	1920	3648
		1994	96	0	0	204	96	72	96	22	240	456	586	1920	3648
		1995	96	0	0	204	96	92	96	56	240	456	640	1920	3648
		1996	96	0	0	204	96	96	96	77	240	456	665	1920	3648
		1997	101	0	0	204	101	96	101	70	240	456	673	1920	3648
		1998	109	0	0	205	109	103	109	93	240	456	728	1920	3648
		1999	126	0	0	216	126	115	126	86	240	456	795	1920	3648
		2000	175	0	0	233	175	138	175	160	240	456	1056	1920	3648
		2001	216	0	0	240	216	198	216	211	240	456	1297	1920	3648
		2002	222	0	0	240	222	219	222	205	240	456	1330	1920	3648
		2003	237	0	0	240	237	228	237	202	240	456	1381	1920	3648
		2004	240	0	0	240	240	238	240	192	240	456	1390	1920	3648
		2005	240	0	0	240	240	240	240	186	240	456	1386	1920	3648
Total			2050	0	0	2874	2050	1907	2050	1562					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Czech Republic	CZ	1993	18	0	0	8	18	10	18	1	216	456	73	1728	3648
		1994	140	0	0	132	140	110	140	64	216	456	726	1728	3648
		1995	194	48	48	184	194	190	194	164	216	456	1216	1728	3648
		1996	204	120	120	192	204	204	204	193	216	456	1441	1728	3648
		1997	204	144	144	192	204	204	204	148	216	456	1444	1728	3648
		1998	204	144	144	192	204	204	204	150	216	456	1446	1728	3648
		1999	204	156	156	192	204	204	204	106	216	456	1426	1728	3648
		2000	204	168	168	192	204	204	204	109	216	456	1453	1728	3648
		2001	204	168	168	197	204	204	204	75	216	456	1424	1728	3648
		2002	204	168	168	204	204	204	204	63	216	456	1419	1728	3648
		2003	204	168	168	204	204	204	204	63	216	456	1419	1728	3648
		2004	211	168	175	211	211	211	211	76	216	456	1474	1728	3648
		2005	216	168	180	216	216	216	216	106	216	456	1534	1728	3648
Total			2411	1620	1639	2316	2411	2369	2411	1318					
Possible			2808	2808	2808	2808	2808	2808	2808	2808					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Denmark	DK	1993	216	156	144	216	216	204	216	146	252	456	1514	2016	3648
		1994	216	165	153	216	216	204	216	141	252	456	1527	2016	3648
		1995	216	168	156	216	216	214	216	186	252	456	1588	2016	3648
		1996	224	188	176	224	224	216	224	188	252	456	1664	2016	3648
		1997	228	192	180	228	228	226	228	176	252	456	1686	2016	3648
		1998	228	201	198	228	228	228	228	189	252	456	1728	2016	3648
		1999	228	216	204	228	228	228	228	170	252	456	1730	2016	3648
		2000	239	227	215	239	239	230	239	224	252	456	1852	2016	3648
		2001	252	240	228	252	252	250	252	217	252	456	1943	2016	3648
		2002	252	240	228	252	252	252	252	203	252	456	1931	2016	3648
		2003	252	240	228	252	252	252	252	228	252	456	1956	2016	3648
		2004	252	240	234	252	252	252	252	205	252	456	1939	2016	3648
		2005	252	240	240	252	252	252	252	237	252	456	1977	2016	3648
Total			3055	2713	2584	3055	3055	3008	3055	2510					
Possible			3276	3276	3276	3276	3276	3276	3276	3276					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Finland	FN	1993	192	216	204	192	192	180	192	95	300	456	1463	2400	3648
		1994	200	219	207	198	200	190	198	101	300	456	1513	2400	3648
		1995	223	247	235	221	223	222	221	120	300	456	1712	2400	3648
		1996	228	252	240	228	228	228	228	126	300	456	1758	2400	3648
		1997	231	264	252	231	231	228	231	115	300	456	1783	2400	3648
		1998	260	264	264	260	260	255	260	146	300	456	1969	2400	3648
		1999	282	277	277	276	282	275	282	224	300	456	2175	2400	3648
		2000	288	288	288	276	288	288	288	281	300	456	2285	2400	3648
		2001	288	288	288	287	288	288	288	258	300	456	2273	2400	3648
		2002	288	288	288	288	288	288	288	237	300	456	2253	2400	3648
		2003	288	288	288	288	288	288	288	262	300	456	2278	2400	3648
		2004	288	288	288	288	288	288	288	264	300	456	2280	2400	3648
		2005	297	288	297	297	297	296	297	297	300	456	2366	2400	3648
Total			3353	3467	3416	3330	3353	3314	3349	2526					
Possible			3900	3900	3900	3900	3900	3900	3900	3900					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
France	FR	1993	396	360	360	396	396	396	396	338	432	456	3038	3456	3648
		1994	396	364	364	396	396	396	396	340	432	456	3048	3456	3648
		1995	396	384	384	396	396	396	396	368	432	456	3116	3456	3648
		1996	396	384	384	396	396	396	396	375	432	456	3123	3456	3648
		1997	399	387	387	399	399	399	399	365	432	456	3134	3456	3648
		1998	411	407	407	408	411	411	411	376	432	456	3242	3456	3648
		1999	420	420	420	419	420	420	420	385	432	456	3324	3456	3648
		2000	420	420	420	420	420	420	420	420	432	456	3360	3456	3648
		2001	420	420	431	420	420	431	420	385	432	456	3347	3456	3648
		2002	420	420	432	420	420	432	420	385	432	456	3349	3456	3648
		2003	420	420	432	420	420	432	420	416	432	456	3380	3456	3648
		2004	420	420	432	420	420	432	420	420	432	456	3384	3456	3648
		2005	421	420	432	421	421	432	421	421	432	456	3389	3456	3648
Total			5335	5226	5285	5331	5335	5393	5335	4994					
Possible			5616	5616	5616	5616	5616	5616	5616	5616					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

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											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Germany	BD	1993	352	278	302	376	352	372	364	262	420	456	2658	3360	3648
		1994	360	288	312	384	360	372	372	322	420	456	2770	3360	3648
		1995	360	288	312	384	360	372	372	322	420	456	2770	3360	3648
		1996	362	302	326	384	362	372	372	298	420	456	2778	3360	3648
		1997	375	326	350	384	375	372	372	282	420	456	2836	3360	3648
		1998	394	368	382	391	394	372	389	334	420	456	3024	3360	3648
		1999	396	376	386	396	396	377	396	348	420	456	3071	3360	3648
		2000	396	406	406	396	396	384	396	383	420	456	3163	3360	3648
		2001	407	408	408	407	407	395	407	355	420	456	3194	3360	3648
		2002	408	408	408	408	408	396	408	325	420	456	3169	3360	3648
		2003	408	408	408	408	408	396	408	352	420	456	3196	3360	3648
		2004	408	408	408	408	408	396	408	352	420	456	3196	3360	3648
		2005	415	408	415	415	415	402	415	402	420	456	3287	3360	3648
Total			5041	4672	4823	5141	5041	4978	5079	4337					
Possible			5460	5460	5460	5460	5460	5460	5460	5460					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Greece	GR	1993	136	132	132	148	136	160	124	115	276	456	1083	2208	3648
		1994	151	132	132	169	151	175	145	115	276	456	1170	2208	3648
		1995	156	132	132	180	156	180	156	126	276	456	1218	2208	3648
		1996	165	153	153	180	165	189	156	144	276	456	1305	2208	3648
		1997	171	163	163	191	171	192	167	159	276	456	1377	2208	3648
		1998	198	185	185	214	198	213	198	188	276	456	1579	2208	3648
		1999	220	204	204	216	220	216	220	179	276	456	1679	2208	3648
		2000	245	224	224	243	245	232	245	225	276	456	1883	2208	3648
		2001	258	246	246	258	258	257	258	232	276	456	2013	2208	3648
		2002	276	264	264	276	276	276	276	253	276	456	2161	2208	3648
		2003	276	269	269	276	276	276	276	276	276	456	2194	2208	3648
		2004	276	276	276	276	276	276	276	253	276	456	2185	2208	3648
		2005	276	276	276	276	276	276	276	253	276	456	2185	2208	3648
Total			2804	2656	2656	2903	2804	2918	2773	2518					
Possible			3588	3588	3588	3588	3588	3588	3588	3588					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Hong Kong	HK	1993	219	109	156	254	219	251	243	218	324	456	1669	2592	3648
		1994	245	144	192	271	245	257	259	241	324	456	1854	2592	3648
		1995	252	168	216	276	252	274	264	229	324	456	1931	2592	3648
		1996	259	234	247	276	259	276	264	257	324	456	2072	2592	3648
		1997	268	240	252	276	268	276	268	224	324	456	2072	2592	3648
		1998	286	241	252	293	286	291	286	252	324	456	2187	2592	3648
		1999	303	252	252	312	303	312	303	270	324	456	2307	2592	3648
		2000	312	259	264	312	312	312	312	306	324	456	2389	2592	3648
		2001	312	264	264	312	312	312	312	284	324	456	2372	2592	3648
		2002	319	270	271	319	319	319	319	290	324	456	2426	2592	3648
		2003	324	280	292	324	324	324	324	294	324	456	2486	2592	3648
		2004	324	308	320	324	324	324	324	324	324	456	2572	2592	3648
		2005	324	312	324	324	324	324	324	312	324	456	2568	2592	3648
Total			3747	3081	3302	3873	3747	3852	3802	3501					
Possible			4212	4212	4212	4212	4212	4212	4212	4212					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Hungary	HN	1993	80	44	44	78	80	78	80	44	252	456	528	2016	3648
		1994	96	48	48	90	96	96	96	84	252	456	654	2016	3648
		1995	110	74	62	106	110	108	110	81	252	456	761	2016	3648
		1996	130	106	108	125	130	113	130	120	252	456	962	2016	3648
		1997	159	119	131	149	159	135	159	127	252	456	1138	2016	3648
		1998	200	189	177	177	200	189	200	172	252	456	1504	2016	3648
		1999	234	211	199	222	234	227	234	197	252	456	1758	2016	3648
		2000	240	216	216	228	240	240	240	229	252	456	1849	2016	3648
		2001	243	216	216	231	243	240	243	182	252	456	1814	2016	3648
		2002	252	216	216	252	252	249	252	199	252	456	1888	2016	3648
		2003	252	218	218	252	252	252	252	210	252	456	1906	2016	3648
		2004	252	228	228	252	252	252	252	200	252	456	1916	2016	3648
		2005	252	229	229	252	252	252	252	193	252	456	1911	2016	3648
Total			2500	2114	2092	2414	2500	2431	2500	2038					
Possible			3276	3276	3276	3276	3276	3276	3276	3276					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

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											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
India	IN	1993	246	189	189	246	246	244	246	0	312	456	1606	2496	3648
		1994	264	192	192	264	264	252	264	0	312	456	1692	2496	3648
		1995	264	228	225	264	264	252	264	192	312	456	1953	2496	3648
		1996	264	240	240	264	264	252	264	219	312	456	2007	2496	3648
		1997	274	248	248	274	274	262	274	236	312	456	2090	2496	3648
		1998	288	252	252	288	288	276	288	254	312	456	2186	2496	3648
		1999	288	276	276	288	288	276	288	233	312	456	2213	2496	3648
		2000	288	276	276	288	288	276	288	277	312	456	2257	2496	3648
		2001	288	276	276	288	288	276	288	256	312	456	2236	2496	3648
		2002	299	287	287	299	299	290	299	268	312	456	2328	2496	3648
		2003	308	296	296	308	308	300	308	304	312	456	2428	2496	3648
		2004	312	300	300	312	312	312	312	311	312	456	2471	2496	3648
		2005	312	300	300	312	312	312	312	311	312	456	2471	2496	3648
Total			3695	3360	3357	3695	3695	3580	3695	2861					
Possible			4056	4056	4056	4056	4056	4056	4056	4056					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Indonesia	ID	1993	142	132	135	142	142	152	142	94	252	456	1081	2016	3648
		1994	150	135	147	150	150	162	150	96	252	456	1140	2016	3648
		1995	191	164	176	191	191	191	191	120	252	456	1415	2016	3648
		1996	216	199	211	216	216	228	216	164	252	456	1666	2016	3648
		1997	216	204	216	216	216	228	216	146	252	456	1658	2016	3648
		1998	216	204	216	216	216	228	216	151	252	456	1663	2016	3648
		1999	216	204	216	216	216	228	216	164	252	456	1676	2016	3648
		2000	216	204	216	216	216	228	216	146	252	456	1658	2016	3648
		2001	217	204	216	217	217	228	217	181	252	456	1697	2016	3648
		2002	234	210	222	234	234	234	234	179	252	456	1781	2016	3648
		2003	241	217	229	241	241	240	241	163	252	456	1813	2016	3648
		2004	252	228	240	252	252	240	252	208	252	456	1924	2016	3648
		2005	252	228	240	252	252	240	252	207	252	456	1923	2016	3648
Total			2759	2533	2680	2759	2759	2827	2759	2019					
Possible			3276	3276	3276	3276	3276	3276	3276	3276					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Ireland	IR	1993	204	132	180	204	204	204	204	0	252	456	1332	2016	3648
		1994	212	140	180	212	212	212	212	0	252	456	1380	2016	3648
		1995	216	156	192	216	216	216	216	0	252	456	1428	2016	3648
		1996	216	156	192	216	216	216	216	0	252	456	1428	2016	3648
		1997	224	156	192	216	224	222	224	0	252	456	1458	2016	3648
		1998	228	168	216	228	228	228	228	0	252	456	1524	2016	3648
		1999	237	184	224	237	237	234	237	0	252	456	1590	2016	3648
		2000	240	193	228	240	240	250	240	67	252	456	1698	2016	3648
		2001	240	204	228	240	240	252	240	201	252	456	1845	2016	3648
		2002	240	204	228	240	240	252	240	176	252	456	1820	2016	3648
		2003	240	204	228	240	240	252	240	200	252	456	1844	2016	3648
		2004	250	222	246	250	250	252	250	220	252	456	1940	2016	3648
		2005	252	228	252	252	252	252	252	231	252	456	1971	2016	3648
Total			2999	2347	2786	2991	2999	3042	2999	1095					
Possible			3276	3276	3276	3276	3276	3276	3276	3276					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Israel	IS	1993	192	80	84	144	192	119	192	42	276	456	1045	2208	3648
		1994	192	96	84	144	192	130	192	148	276	456	1178	2208	3648
		1995	192	96	84	145	192	132	192	147	276	456	1180	2208	3648
		1996	192	96	84	156	192	132	192	140	276	456	1184	2208	3648
		1997	192	129	108	156	192	132	192	161	276	456	1262	2208	3648
		1998	247	182	163	220	247	196	247	162	276	456	1664	2208	3648
		1999	252	204	180	242	252	246	252	208	276	456	1836	2208	3648
		2000	252	240	228	252	252	252	252	229	276	456	1957	2208	3648
		2001	258	246	258	258	258	252	258	251	276	456	2039	2208	3648
		2002	264	264	264	264	264	252	264	262	276	456	2098	2208	3648
		2003	271	271	271	271	271	258	271	243	276	456	2127	2208	3648
		2004	276	276	276	276	276	264	276	253	276	456	2173	2208	3648
		2005	276	276	276	276	276	264	276	276	276	456	2196	2208	3648
Total			3056	2456	2360	2804	3056	2629	3056	2522					
Possible			3588	3588	3588	3588	3588	3588	3588	3588					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

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Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE Possible	PER VARIABLE Theoretical	ALL VARIABLES (PI to VO) Total	ALL VARIABLES (PI to VO) Possible	ALL VARIABLES (PI to VO) Theoretical
Italy	IT	1993	336	264	276	348	336	348	336	163	396	456	2407	3168	3648
		1994	336	264	276	348	336	348	336	310	396	456	2554	3168	3648
		1995	336	275	287	348	336	348	336	329	396	456	2595	3168	3648
		1996	336	300	312	348	336	348	336	328	396	456	2644	3168	3648
		1997	336	312	324	348	336	348	336	303	396	456	2643	3168	3648
		1998	336	318	330	348	336	356	336	306	396	456	2666	3168	3648
		1999	338	324	336	348	338	360	338	309	396	456	2691	3168	3648
		2000	350	326	338	350	350	360	350	348	396	456	2772	3168	3648
		2001	373	349	361	373	373	384	373	340	396	456	2926	3168	3648
		2002	384	361	373	384	384	396	384	320	396	456	2986	3168	3648
		2003	384	372	384	384	384	396	384	344	396	456	3032	3168	3648
		2004	384	372	384	384	384	396	384	341	396	456	3029	3168	3648
		2005	391	372	391	391	391	396	391	373	396	456	3096	3168	3648
Total			4620	4209	4372	4702	4620	4784	4620	4114					
Possible			5148	5148	5148	5148	5148	5148	5148	5148					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Japan	JP	1993	388	384	0	408	388	408	408	355	444	456	2739	3552	3648
		1994	399	387	0	408	399	408	408	364	444	456	2773	3552	3648
		1995	408	396	0	408	408	408	408	407	444	456	2843	3552	3648
		1996	408	407	0	408	408	408	408	372	444	456	2819	3552	3648
		1997	408	408	0	408	408	408	408	374	444	456	2822	3552	3648
		1998	408	408	0	408	408	408	408	373	444	456	2821	3552	3648
		1999	411	411	0	411	411	408	411	376	444	456	2839	3552	3648
		2000	420	420	0	420	420	416	420	419	444	456	2935	3552	3648
		2001	420	420	0	420	420	420	420	350	444	456	2870	3552	3648
		2002	429	420	0	429	429	427	429	392	444	456	2955	3552	3648
		2003	438	426	0	438	438	437	438	400	444	456	3015	3552	3648
		2004	444	441	0	444	444	444	444	406	444	456	3067	3552	3648
		2005	444	444	0	444	444	444	444	407	444	456	3071	3552	3648
Total			5425	5372	0	5454	5425	5444	5454	4995					
Possible			5772	5772	5772	5772	5772	5772	5772	5772					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Luxembourg	LX	1993	156	60	48	156	156	128	156	0	204	456	860	1632	3648
		1994	156	60	60	156	156	132	156	0	204	456	876	1632	3648
		1995	156	72	72	156	156	132	156	0	204	456	900	1632	3648
		1996	156	84	96	156	156	132	156	0	204	456	936	1632	3648
		1997	185	101	96	185	185	154	185	0	204	456	1091	1632	3648
		1998	192	115	120	192	192	168	192	0	204	456	1171	1632	3648
		1999	192	132	120	192	192	168	192	82	204	456	1270	1632	3648
		2000	198	174	162	198	198	174	198	82	204	456	1384	1632	3648
		2001	204	180	180	204	204	191	204	83	204	456	1450	1632	3648
		2002	204	180	180	204	204	192	204	66	204	456	1434	1632	3648
		2003	204	180	180	204	204	192	204	75	204	456	1443	1632	3648
		2004	204	180	180	204	204	192	204	68	204	456	1436	1632	3648
		2005	204	180	180	204	204	192	204	74	204	456	1442	1632	3648
Total			2411	1698	1674	2411	2411	2147	2411	530					
Possible			2652	2652	2652	2652	2652	2652	2652	2652					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Malaysia	MY	1993	240	192	216	252	240	264	252	200	300	456	1856	2400	3648
		1994	240	192	216	252	240	264	252	220	300	456	1876	2400	3648
		1995	242	218	254	252	242	264	252	181	300	456	1905	2400	3648
		1996	254	230	266	254	254	266	254	233	300	456	2011	2400	3648
		1997	271	252	276	271	271	276	271	270	300	456	2158	2400	3648
		1998	282	270	288	282	282	291	282	232	300	456	2209	2400	3648
		1999	288	276	288	288	288	300	288	239	300	456	2255	2400	3648
		2000	288	288	300	288	288	300	288	239	300	456	2279	2400	3648
		2001	288	288	300	288	288	300	288	257	300	456	2297	2400	3648
		2002	288	288	300	288	288	300	288	284	300	456	2324	2400	3648
		2003	288	296	300	288	288	300	288	264	300	456	2312	2400	3648
		2004	288	300	300	288	288	300	288	262	300	456	2314	2400	3648
		2005	300	300	300	300	300	300	300	272	300	456	2372	2400	3648
Total			3557	3390	3604	3591	3557	3725	3591	3153					
Possible			3900	3900	3900	3900	3900	3900	3900	3900					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

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Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE Possible	PER VARIABLE Theoretical	ALL VARIABLES (PI to VO) Total	ALL VARIABLES (PI to VO) Possible	ALL VARIABLES (PI to VO) Theoretical
Mexico	MX	1993	181	134	108	170	181	181	181	143	300	456	1279	2400	3648
		1994	209	161	144	202	209	213	209	168	300	456	1515	2400	3648
		1995	216	180	180	216	216	227	216	194	300	456	1645	2400	3648
		1996	223	184	184	220	223	228	223	207	300	456	1692	2400	3648
		1997	228	192	192	228	228	231	228	210	300	456	1737	2400	3648
		1998	234	210	192	242	234	243	234	205	300	456	1794	2400	3648
		1999	240	240	252	252	240	252	240	189	300	456	1905	2400	3648
		2000	240	244	256	252	240	252	240	202	300	456	1926	2400	3648
		2001	251	252	264	263	251	263	251	213	300	456	2008	2400	3648
		2002	267	261	273	279	267	264	267	201	300	456	2079	2400	3648
		2003	276	264	276	288	276	266	276	224	300	456	2146	2400	3648
		2004	283	264	276	288	283	282	283	226	300	456	2185	2400	3648
		2005	290	264	276	290	290	288	290	245	300	456	2233	2400	3648
Total			3138	2850	2873	3190	3138	3190	3138	2627					
Possible			3900	3900	3900	3900	3900	3900	3900	3900					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
New Zealand	NZ	1993	156	36	96	180	156	180	180	150	240	456	1134	1920	3648
		1994	176	96	132	190	176	180	190	161	240	456	1301	1920	3648
		1995	184	124	144	192	184	181	192	159	240	456	1360	1920	3648
		1996	192	168	168	192	192	192	192	187	240	456	1483	1920	3648
		1997	192	168	168	192	192	200	192	176	240	456	1480	1920	3648
		1998	192	168	168	192	192	204	192	192	240	456	1500	1920	3648
		1999	199	172	184	199	199	204	199	181	240	456	1537	1920	3648
		2000	204	180	198	204	204	204	204	203	240	456	1601	1920	3648
		2001	216	204	206	216	216	214	216	214	240	456	1702	1920	3648
		2002	228	216	216	228	228	223	228	208	240	456	1775	1920	3648
		2003	228	216	216	228	228	228	228	225	240	456	1797	1920	3648
		2004	228	216	222	228	228	228	228	222	240	456	1800	1920	3648
		2005	233	228	233	233	233	233	233	220	240	456	1846	1920	3648
Total			2628	2192	2351	2674	2628	2671	2674	2498					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Netherlands	NL	1993	288	264	288	324	288	312	312	213	348	456	2289	2784	3648
		1994	295	271	295	324	295	312	312	267	348	456	2371	2784	3648
		1995	310	283	300	324	310	312	312	277	348	456	2428	2784	3648
		1996	312	288	312	324	312	312	312	259	348	456	2431	2784	3648
		1997	312	293	317	324	312	312	312	232	348	456	2414	2784	3648
		1998	320	308	324	324	320	312	320	267	348	456	2495	2784	3648
		1999	324	321	327	318	324	310	324	267	348	456	2515	2784	3648
		2000	327	327	324	327	327	327	327	327	348	456	2613	2784	3648
		2001	336	336	324	336	336	336	336	273	348	456	2613	2784	3648
		2002	336	336	330	336	336	336	336	304	348	456	2650	2784	3648
		2003	336	336	336	336	336	336	336	333	348	456	2685	2784	3648
		2004	336	336	336	336	336	336	336	328	348	456	2680	2784	3648
		2005	336	336	336	336	336	336	336	336	348	456	2688	2784	3648
Total			4168	4035	4149	4269	4168	4189	4211	3683					
Possible			4524	4524	4524	4524	4524	4524	4524	4524					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Norway	NW	1993	157	145	169	169	157	180	169	119	264	456	1265	2112	3648
		1994	168	156	180	180	168	180	180	139	264	456	1351	2112	3648
		1995	177	177	189	189	177	180	189	166	264	456	1444	2112	3648
		1996	188	180	192	192	188	188	192	164	264	456	1484	2112	3648
		1997	208	182	194	208	208	216	208	163	264	456	1587	2112	3648
		1998	228	192	216	228	228	216	228	188	264	456	1724	2112	3648
		1999	228	197	221	228	228	232	228	186	264	456	1748	2112	3648
		2000	237	205	237	237	237	248	237	234	264	456	1872	2112	3648
		2001	252	223	252	252	252	252	252	226	264	456	1961	2112	3648
		2002	252	228	252	252	252	261	252	207	264	456	1956	2112	3648
		2003	252	228	252	252	252	264	252	224	264	456	1976	2112	3648
		2004	262	238	262	262	262	264	262	198	264	456	2010	2112	3648
		2005	264	240	264	264	264	264	264	240	264	456	2064	2112	3648
Total			2873	2591	2880	2913	2873	2945	2913	2454					
Possible			3432	3432	3432	3432	3432	3432	3432	3432					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) RawData Availability by Country and Year

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Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE Possible	PER VARIABLE Theoretical	ALL VARIABLES (PI to VO) Total	ALL VARIABLES (PI to VO) Possible	ALL VARIABLES (PI to VO) Theoretical
Peru	PE	1993	48	0	0	48	48	37	48	16	204	456	245	1632	3648
		1994	135	84	72	147	135	132	147	76	204	456	928	1632	3648
		1995	146	84	72	158	146	146	158	90	204	456	1000	1632	3648
		1996	162	95	83	168	162	156	168	83	204	456	1077	1632	3648
		1997	168	108	108	168	168	156	168	103	204	456	1147	1632	3648
		1998	168	120	120	168	168	156	168	94	204	456	1162	1632	3648
		1999	172	149	153	172	172	160	172	82	204	456	1232	1632	3648
		2000	180	156	168	180	180	168	180	99	204	456	1311	1632	3648
		2001	192	156	163	192	192	168	192	87	204	456	1342	1632	3648
		2002	192	168	168	192	192	168	192	76	204	456	1348	1632	3648
		2003	196	168	168	196	196	168	196	101	204	456	1389	1632	3648
		2004	204	168	168	204	204	182	204	94	204	456	1428	1632	3648
		2005	204	168	168	204	204	192	204	106	204	456	1450	1632	3648
Total			2167	1624	1611	2197	2167	1989	2197	1107					
Possible			2652	2652	2652	2652	2652	2652	2652	2652					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Philippines	PH	1993	168	96	108	180	168	175	180	114	252	456	1189	2016	3648
		1994	172	112	124	180	172	180	180	98	252	456	1218	2016	3648
		1995	180	132	145	180	180	180	180	146	252	456	1323	2016	3648
		1996	180	151	175	180	180	183	180	152	252	456	1381	2016	3648
		1997	181	156	180	181	181	192	181	152	252	456	1404	2016	3648
		1998	198	156	180	198	198	192	198	125	252	456	1445	2016	3648
		1999	213	168	189	213	213	195	213	148	252	456	1552	2016	3648
		2000	226	192	204	226	226	220	226	175	252	456	1695	2016	3648
		2001	228	192	216	228	228	228	228	147	252	456	1695	2016	3648
		2002	228	192	216	228	228	228	228	122	252	456	1670	2016	3648
		2003	228	192	216	228	228	228	228	154	252	456	1702	2016	3648
		2004	228	192	228	228	228	228	228	157	252	456	1717	2016	3648
		2005	248	213	248	248	248	246	248	163	252	456	1862	2016	3648
Total			2678	2144	2429	2698	2678	2675	2698	1853					
Possible			3276	3276	3276	3276	3276	3276	3276	3276					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Poland	PO	1993	20	12	12	44	20	7	20	4	288	456	139	2304	3648
		1994	60	22	12	78	60	50	60	24	288	456	366	2304	3648
		1995	80	36	24	90	80	80	80	64	288	456	534	2304	3648
		1996	101	41	29	116	101	106	96	81	288	456	671	2304	3648
		1997	135	84	66	138	135	132	123	117	288	456	930	2304	3648
		1998	176	122	98	168	176	183	167	174	288	456	1264	2304	3648
		1999	212	179	155	212	212	222	212	193	288	456	1597	2304	3648
		2000	230	216	192	230	230	229	230	229	288	456	1786	2304	3648
		2001	248	236	224	248	248	255	248	245	288	456	1952	2304	3648
		2002	252	240	228	252	252	264	252	228	288	456	1968	2304	3648
		2003	254	252	240	254	254	264	254	249	288	456	2021	2304	3648
		2004	270	253	241	270	270	265	270	258	288	456	2097	2304	3648
		2005	276	272	260	276	276	276	276	261	288	456	2173	2304	3648
Total			2314	1965	1781	2376	2314	2333	2288	2127					
Possible			3744	3744	3744	3744	3744	3744	3744	3744					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Portugal	PT	1993	144	96	132	168	144	156	156	60	240	456	1056	1920	3648
		1994	144	108	132	168	144	156	156	111	240	456	1119	1920	3648
		1995	151	122	132	168	151	156	163	112	240	456	1155	1920	3648
		1996	157	132	144	178	157	166	168	137	240	456	1239	1920	3648
		1997	178	139	163	181	178	170	178	151	240	456	1338	1920	3648
		1998	210	155	191	207	210	189	210	180	240	456	1552	1920	3648
		1999	222	188	216	222	222	204	222	194	240	456	1690	1920	3648
		2000	228	211	216	228	228	220	228	218	240	456	1777	1920	3648
		2001	228	216	216	228	228	228	228	194	240	456	1766	1920	3648
		2002	228	216	228	228	228	228	228	185	240	456	1769	1920	3648
		2003	234	222	234	234	234	234	234	196	240	456	1822	1920	3648
		2004	240	228	240	240	240	240	240	210	240	456	1878	1920	3648
		2005	240	228	240	240	240	240	240	212	240	456	1880	1920	3648
Total			2604	2261	2484	2690	2604	2587	2651	2160					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

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Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE Possible	PER VARIABLE Theoretical	ALL VARIABLES (PI to VO) Total	ALL VARIABLES (PI to VO) Possible	ALL VARIABLES (PI to VO) Theoretical
Russia	RS	1993	0	0	0	0	0	0	0	0	180	456	0	1440	3648
		1994	32	0	0	0	32	0	32	0	180	456	96	1440	3648
		1995	64	8	0	16	64	22	64	4	180	456	242	1440	3648
		1996	79	48	0	46	79	48	79	31	180	456	410	1440	3648
		1997	91	48	0	76	91	69	91	56	180	456	522	1440	3648
		1998	108	60	0	96	108	101	108	57	180	456	638	1440	3648
		1999	108	72	0	103	108	108	108	62	180	456	669	1440	3648
		2000	108	84	0	108	108	108	108	64	180	456	688	1440	3648
		2001	108	108	0	108	108	108	108	44	180	456	692	1440	3648
		2002	122	120	0	122	122	108	122	78	180	456	794	1440	3648
		2003	135	123	0	135	135	118	135	85	180	456	866	1440	3648
		2004	146	133	0	146	146	130	146	87	180	456	934	1440	3648
		2005	178	164	0	178	178	152	178	129	180	456	1157	1440	3648
Total			1279	968	0	1134	1279	1072	1279	697					
Possible			2340	2340	2340	2340	2340	2340	2340	2340					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Singapore	SG	1993	210	170	146	220	210	220	220	205	300	456	1601	2400	3648
		1994	239	216	192	228	239	239	239	234	300	456	1826	2400	3648
		1995	247	247	223	238	247	247	247	224	300	456	1920	2400	3648
		1996	252	252	228	252	252	252	252	225	300	456	1965	2400	3648
		1997	253	253	229	252	253	253	253	251	300	456	1997	2400	3648
		1998	264	264	240	262	264	264	264	238	300	456	2060	2400	3648
		1999	269	276	264	269	269	264	269	244	300	456	2124	2400	3648
		2000	288	300	288	288	288	283	288	281	300	456	2304	2400	3648
		2001	288	300	288	288	288	288	288	275	300	456	2303	2400	3648
		2002	289	300	288	289	289	288	289	264	300	456	2296	2400	3648
		2003	300	300	288	300	300	300	300	298	300	456	2386	2400	3648
		2004	300	300	300	300	300	300	300	300	300	456	2400	2400	3648
		2005	300	300	300	300	300	300	300	290	300	456	2390	2400	3648
Total			3499	3478	3274	3486	3499	3498	3509	3329					
Possible			3900	3900	3900	3900	3900	3900	3900	3900					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
South Africa	SA	1993	264	204	204	288	264	300	288	162	336	456	1974	2688	3648
		1994	267	204	204	288	267	300	288	169	336	456	1987	2688	3648
		1995	276	204	204	288	276	300	288	198	336	456	2034	2688	3648
		1996	307	217	217	297	307	309	309	270	336	456	2233	2688	3648
		1997	312	252	264	310	312	319	312	277	336	456	2358	2688	3648
		1998	316	300	294	316	316	328	316	303	336	456	2489	2688	3648
		1999	324	324	324	324	324	336	324	291	336	456	2571	2688	3648
		2000	324	324	324	324	324	336	324	316	336	456	2596	2688	3648
		2001	324	324	324	324	324	336	324	319	336	456	2599	2688	3648
		2002	324	324	324	324	324	336	324	294	336	456	2574	2688	3648
		2003	334	334	334	334	334	336	334	333	336	456	2673	2688	3648
		2004	336	336	336	336	336	336	336	335	336	456	2687	2688	3648
		2005	336	336	336	336	336	336	336	335	336	456	2687	2688	3648
Total			4044	3683	3689	4089	4044	4208	4103	3602					
Possible			4368	4368	4368	4368	4368	4368	4368	4368					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
South Korea	KO	1993	276	252	288	300	276	276	300	230	384	456	2198	3072	3648
		1994	276	264	300	300	276	276	300	251	384	456	2243	3072	3648
		1995	281	264	300	300	281	281	300	228	384	456	2235	3072	3648
		1996	301	264	300	301	301	301	301	270	384	456	2339	3072	3648
		1997	312	276	312	312	312	312	312	277	384	456	2425	3072	3648
		1998	322	277	313	322	322	322	322	295	384	456	2495	3072	3648
		1999	338	304	337	335	338	333	338	307	384	456	2630	3072	3648
		2000	372	330	366	365	372	358	372	341	384	456	2876	3072	3648
		2001	372	336	372	372	372	368	372	341	384	456	2905	3072	3648
		2002	377	345	372	377	377	377	377	345	384	456	2947	3072	3648
		2003	384	348	384	384	384	384	384	310	384	456	2962	3072	3648
		2004	384	348	384	384	384	384	384	325	384	456	2977	3072	3648
		2005	384	348	384	384	384	384	384	319	384	456	2971	3072	3648
Total			4379	3956	4412	4436	4379	4356	4446	3839					
Possible			4992	4992	4992	4992	4992	4992	4992	4992					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

-continued.

Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE Possible	PER VARIABLE Theoretical	ALL VARIABLES (PI to VO) Total	ALL VARIABLES (PI to VO) Possible	ALL VARIABLES (PI to VO) Theoretical
Spain	ES	1993	276	288	288	312	276	276	288	244	384	456	2248	3072	3648
		1994	276	294	294	312	276	276	288	235	384	456	2251	3072	3648
		1995	276	312	312	312	276	276	288	250	384	456	2302	3072	3648
		1996	282	324	324	312	282	276	288	267	384	456	2355	3072	3648
		1997	299	336	336	313	299	290	299	296	384	456	2468	3072	3648
		1998	314	348	348	325	314	314	314	285	384	456	2562	3072	3648
		1999	338	355	355	338	338	338	338	298	384	456	2698	3072	3648
		2000	350	362	362	350	350	350	350	340	384	456	2814	3072	3648
		2001	372	384	384	372	372	372	372	322	384	456	2950	3072	3648
		2002	379	384	384	379	379	379	379	299	384	456	2962	3072	3648
		2003	384	384	384	384	384	384	384	345	384	456	3033	3072	3648
		2004	384	384	384	384	384	384	384	343	384	456	3031	3072	3648
		2005	384	384	384	384	384	384	384	384	384	456	3072	3072	3648
Total			4314	4539	4539	4477	4314	4299	4356	3908					
Possible			4992	4992	4992	4992	4992	4992	4992	4992					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Sweden	SD	1993	228	204	204	264	228	259	264	184	348	456	1835	2784	3648
		1994	236	204	204	264	236	264	264	235	348	456	1907	2784	3648
		1995	247	204	204	271	247	264	271	245	348	456	1953	2784	3648
		1996	260	220	232	276	260	273	276	238	348	456	2035	2784	3648
		1997	275	251	243	283	275	283	283	229	348	456	2122	2784	3648
		1998	295	271	271	288	295	288	295	270	348	456	2273	2784	3648
		1999	308	284	284	307	308	296	308	281	348	456	2376	2784	3648
		2000	319	307	319	319	319	307	319	315	348	456	2524	2784	3648
		2001	328	316	324	328	328	316	328	296	348	456	2564	2784	3648
		2002	336	324	336	336	336	324	336	280	348	456	2608	2784	3648
		2003	336	324	336	336	336	324	336	308	348	456	2636	2784	3648
		2004	336	324	336	336	336	335	336	280	348	456	2619	2784	3648
		2005	340	328	340	340	340	340	340	328	348	456	2696	2784	3648
Total			3844	3561	3633	3948	3844	3873	3956	3489					
Possible			4524	4524	4524	4524	4524	4524	4524	4524					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Switzerland	SW	1993	288	288	288	324	288	324	324	235	360	456	2359	2880	3648
		1994	289	296	296	324	289	324	324	261	360	456	2403	2880	3648
		1995	307	300	300	324	307	324	324	279	360	456	2465	2880	3648
		1996	312	312	300	324	312	324	324	308	360	456	2516	2880	3648
		1997	312	312	300	324	312	324	324	284	360	456	2492	2880	3648
		1998	315	315	303	324	315	324	324	288	360	456	2508	2880	3648
		1999	324	324	324	324	324	324	324	297	360	456	2565	2880	3648
		2000	338	324	324	338	338	338	338	337	360	456	2675	2880	3648
		2001	355	338	331	355	355	348	355	325	360	456	2762	2880	3648
		2002	360	348	336	360	360	359	360	299	360	456	2782	2880	3648
		2003	360	348	348	360	360	360	360	330	360	456	2826	2880	3648
		2004	360	348	348	360	360	360	360	300	360	456	2796	2880	3648
		2005	360	357	357	360	360	360	360	360	360	456	2874	2880	3648
Total			4280	4210	4155	4401	4280	4393	4401	3903					
Possible			4680	4680	4680	4680	4680	4680	4680	4680					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Taiwan	TA	1993	154	96	96	155	154	154	154	141	240	456	1104	1920	3648
		1994	156	144	144	156	156	156	156	143	240	456	1211	1920	3648
		1995	157	144	144	157	157	156	157	131	240	456	1203	1920	3648
		1996	168	144	144	168	168	156	168	126	240	456	1242	1920	3648
		1997	188	160	172	188	188	178	188	155	240	456	1417	1920	3648
		1998	204	168	180	204	204	204	204	187	240	456	1555	1920	3648
		1999	206	170	182	206	206	204	206	188	240	456	1568	1920	3648
		2000	223	187	199	223	223	210	223	223	240	456	1711	1920	3648
		2001	240	204	216	240	240	236	240	219	240	456	1835	1920	3648
		2002	240	224	236	240	240	240	240	220	240	456	1880	1920	3648
		2003	240	228	240	240	240	240	240	191	240	456	1859	1920	3648
		2004	240	228	240	240	240	240	240	228	240	456	1896	1920	3648
		2005	240	228	240	240	240	240	240	209	240	456	1877	1920	3648
Total			2656	2325	2433	2657	2656	2614	2656	2361					
Possible			3120	3120	3120	3120	3120	3120	3120	3120					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

-continued.

											PER VARIABLE		ALL VARIABLES (PI to VO)		
Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	Possible	Theoretical	Total	Possible	Theoretical
Thailand	TH	1993	199	151	163	220	199	226	227	177	264	456	1562	2112	3648
		1994	216	168	185	228	216	228	228	208	264	456	1677	2112	3648
		1995	239	202	226	239	239	228	239	234	264	456	1846	2112	3648
		1996	249	225	240	249	249	237	249	185	264	456	1883	2112	3648
		1997	252	228	252	252	252	240	252	246	264	456	1974	2112	3648
		1998	252	228	252	252	252	240	252	222	264	456	1950	2112	3648
		1999	252	228	252	252	252	250	252	200	264	456	1938	2112	3648
		2000	252	228	252	252	252	252	252	243	264	456	1983	2112	3648
		2001	252	228	252	252	252	252	252	227	264	456	1967	2112	3648
		2002	252	228	252	252	252	252	252	225	264	456	1965	2112	3648
		2003	255	231	255	255	255	252	255	252	264	456	2010	2112	3648
		2004	264	240	264	264	264	262	264	223	264	456	2045	2112	3648
		2005	264	240	264	264	264	264	264	240	264	456	2064	2112	3648
Total			3198	2825	3109	3231	3198	3183	3238	2882					
Possible			3432	3432	3432	3432	3432	3432	3432	3432					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
Turkey	TK	1993	216	108	60	221	216	216	209	174	276	456	1420	2208	3648
		1994	217	108	60	228	217	216	216	200	276	456	1462	2208	3648
		1995	228	108	60	238	228	226	226	218	276	456	1532	2208	3648
		1996	228	144	72	240	228	228	228	169	276	456	1537	2208	3648
		1997	228	168	72	240	228	228	228	228	276	456	1620	2208	3648
		1998	228	168	72	240	228	228	228	190	276	456	1582	2208	3648
		1999	228	204	84	240	228	228	228	171	276	456	1611	2208	3648
		2000	253	241	102	265	253	243	253	230	276	456	1840	2208	3648
		2001	264	252	108	276	264	255	264	242	276	456	1925	2208	3648
		2002	264	252	108	276	264	264	264	242	276	456	1934	2208	3648
		2003	261	264	105	273	261	261	261	240	276	456	1926	2208	3648
		2004	259	264	96	264	259	252	259	213	276	456	1866	2208	3648
		2005	264	264	96	264	264	261	264	264	276	456	1941	2208	3648
Total			3138	2545	1095	3265	3138	3106	3128	2781					
Possible			3588	3588	3588	3588	3588	3588	3588	3588					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
U.K.	UK	1993	456	444	444	456	456	456	456	413	456	456	3581	3648	3648
		1994	456	444	444	456	456	456	456	451	456	456	3619	3648	3648
		1995	456	444	444	456	456	456	456	454	456	456	3622	3648	3648
		1996	456	444	444	456	456	456	456	455	456	456	3623	3648	3648
		1997	456	444	444	456	456	456	456	417	456	456	3585	3648	3648
		1998	456	450	444	456	456	456	456	380	456	456	3554	3648	3648
		1999	456	456	452	456	456	456	456	380	456	456	3568	3648	3648
		2000	456	456	456	456	456	456	456	455	456	456	3647	3648	3648
		2001	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2002	456	456	456	456	456	456	456	418	456	456	3610	3648	3648
		2003	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2004	456	456	456	456	456	456	456	418	456	456	3610	3648	3648
		2005	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
Total			5928	5862	5852	5928	5928	5928	5928	5609					
Possible			5928	5928	5928	5928	5928	5928	5928	5928					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					
U.S.A.	US	1993	456	456	456	456	456	456	456	418	456	456	3610	3648	3648
		1994	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		1995	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		1996	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		1997	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		1998	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		1999	456	456	456	456	456	456	456	418	456	456	3610	3648	3648
		2000	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2001	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2002	456	456	456	456	456	456	456	418	456	456	3610	3648	3648
		2003	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
		2004	456	456	456	456	456	456	456	418	456	456	3610	3648	3648
		2005	456	456	456	456	456	456	456	456	456	456	3648	3648	3648
Total			5928	5928	5928	5928	5928	5928	5928	5776					
Possible			5928	5928	5928	5928	5928	5928	5928	5928					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix A.7: Sector Index (ICB Level 4) Raw Data Availability by Country and Year

-continued.

Country	Code	Year	PI	BP	PC	DY	MV	PE	RI	VO	PER VARIABLE		ALL VARIABLES (PI to VO)		
											Possible	Theoretical	Total	Possible	Theoretical
Venezuela	VE	1993	84	0	0	156	84	84	84	77	192	456	569	1536	3648
		1994	100	0	0	156	100	100	100	73	192	456	629	1536	3648
		1995	108	0	0	156	108	108	108	91	192	456	679	1536	3648
		1996	110	0	0	156	110	108	110	107	192	456	701	1536	3648
		1997	120	0	0	156	120	108	120	113	192	456	737	1536	3648
		1998	120	0	0	156	120	108	120	102	192	456	726	1536	3648
		1999	144	0	0	156	144	108	144	101	192	456	797	1536	3648
		2000	179	0	0	181	179	115	179	127	192	456	960	1536	3648
		2001	192	0	0	192	192	123	192	117	192	456	1008	1536	3648
		2002	192	0	0	192	192	150	192	78	192	456	996	1536	3648
		2003	192	0	0	192	192	168	192	100	192	456	1036	1536	3648
		2004	192	0	0	192	192	168	192	129	192	456	1065	1536	3648
		2005	192	0	0	192	192	168	192	112	192	456	1048	1536	3648
Total			1925	0	0	2233	1925	1616	1925	1327					
Possible			2496	2496	2496	2496	2496	2496	2496	2496					
Theoretical			5928	5928	5928	5928	5928	5928	5928	5928					

Appendix B

Appendix B contains material associated with chapter 5: Exploratory Analysis and Market Risk Decomposition.

Appendix B.1: Sectors Omitted in Regression Tests of Chapter 5

The table shows the eight sectors omitted in the Single-Index, empirical ICAPM and Multi-Index model OLS regression tests of chapter 5. The sectors are all omitted because of insufficient data in the out-sample period.

Country	Sector	Code
Brazil	Real Estate	BRRLEST
China	Automobiles and Parts	CHAUTMB
China A	Industrial Engineering	CAINDEN
France	Mobile Communications	FRTELMB
Mexico	Support Services	MXSUPSV
New Zealand	Gas, Water and Multiutilities	NZGWMUT
Netherlands	Nonlife Insurance	NLNLINS
Sweden	Food Producers	SDFOODS

Appendix B.2: FTSE International Developed and Emerging Market Classifications

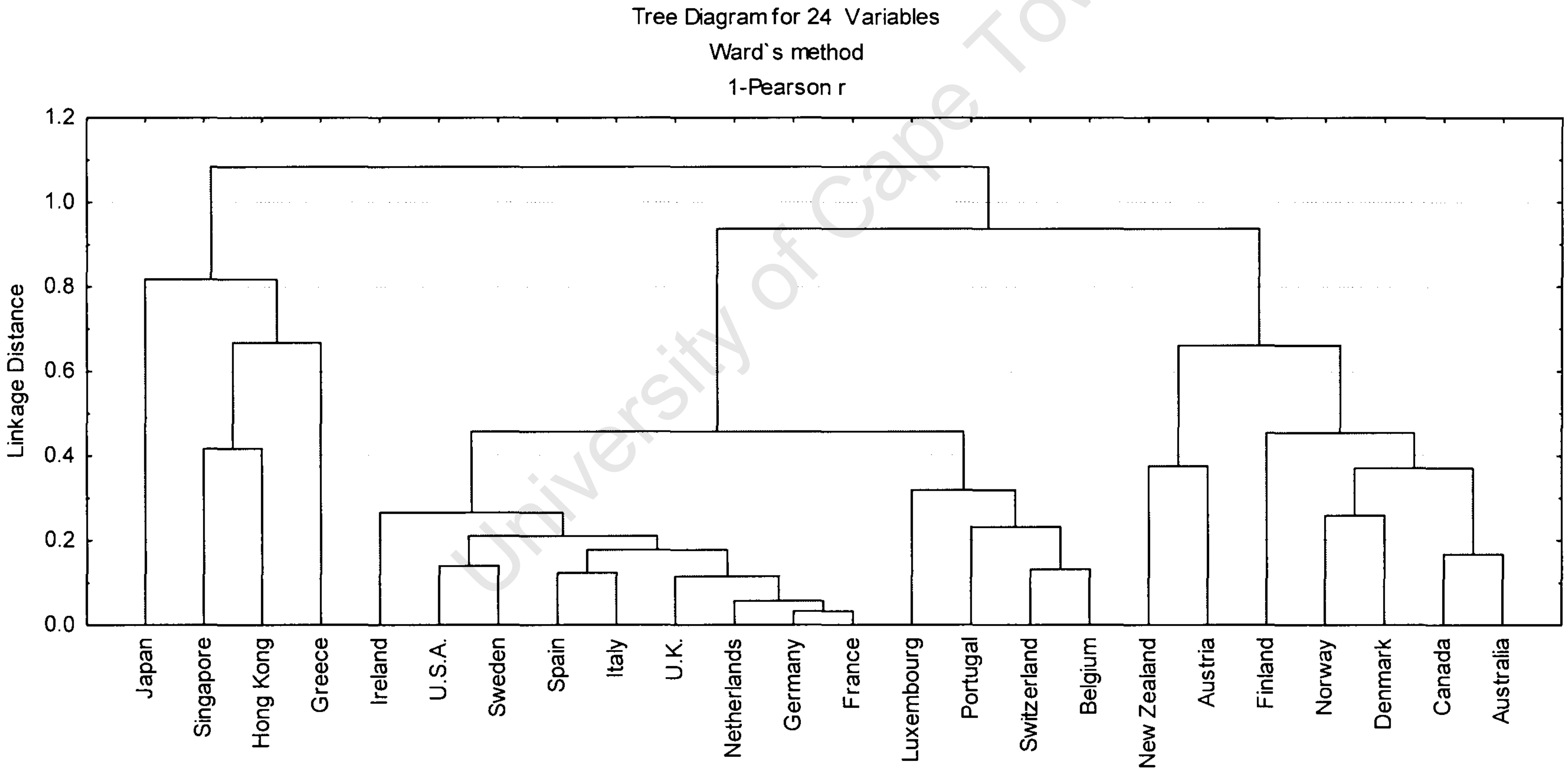
The table shows the FTSE International Limited developed and emerging market classifications as at September 2005. The classifications are available online at www.ftse.com or can be obtained by emailing: info@ftse.com

Developed		Emerging	
Code	**Country**	**Code**	**Country**
AU	Australia	AR	Argentina
OE	Austria	BR	Brazil [a]
BG	Belgium	CL	Chile
CN	Canada	CH	China
DK	Denmark	CA	China A [b]
FN	Finland	CB	Columbia
FR	France	CP	Cyprus [c]
BD	Germany	CZ	Czech Republic
GR	Greece	HN	Hungary
HK	Hong Kong	IN	India
IR	Ireland	ID	Indonesia
IT	Italy	IS	Israel [a]
JP	Japan	MY	Malaysia
LX	Luxembourg	MX	Mexico [a]
NL	Netherlands	PE	Peru
NZ	New Zealand	PH	Philippines
NW	Norway	PO	Poland
PT	Portugal	RS	Russia
SG	Singapore	SA	South Africa [a]
ES	Spain	KO	South Korea [a d]
SD	Sweden	TA	Taiwan [a d]
SW	Switzerland	TH	Thailand
UK	U.K.	TK	Turkey
US	U.S.A.	VE	Venezuela [c]

[a] classified as "advanced emerging" by FTSE International Limited
[b] not yet in FTSE classification: still under consideration
[c] not listed in FTSE classification but assigned at author's discretion
[d] under consideration for possible promotion to developed

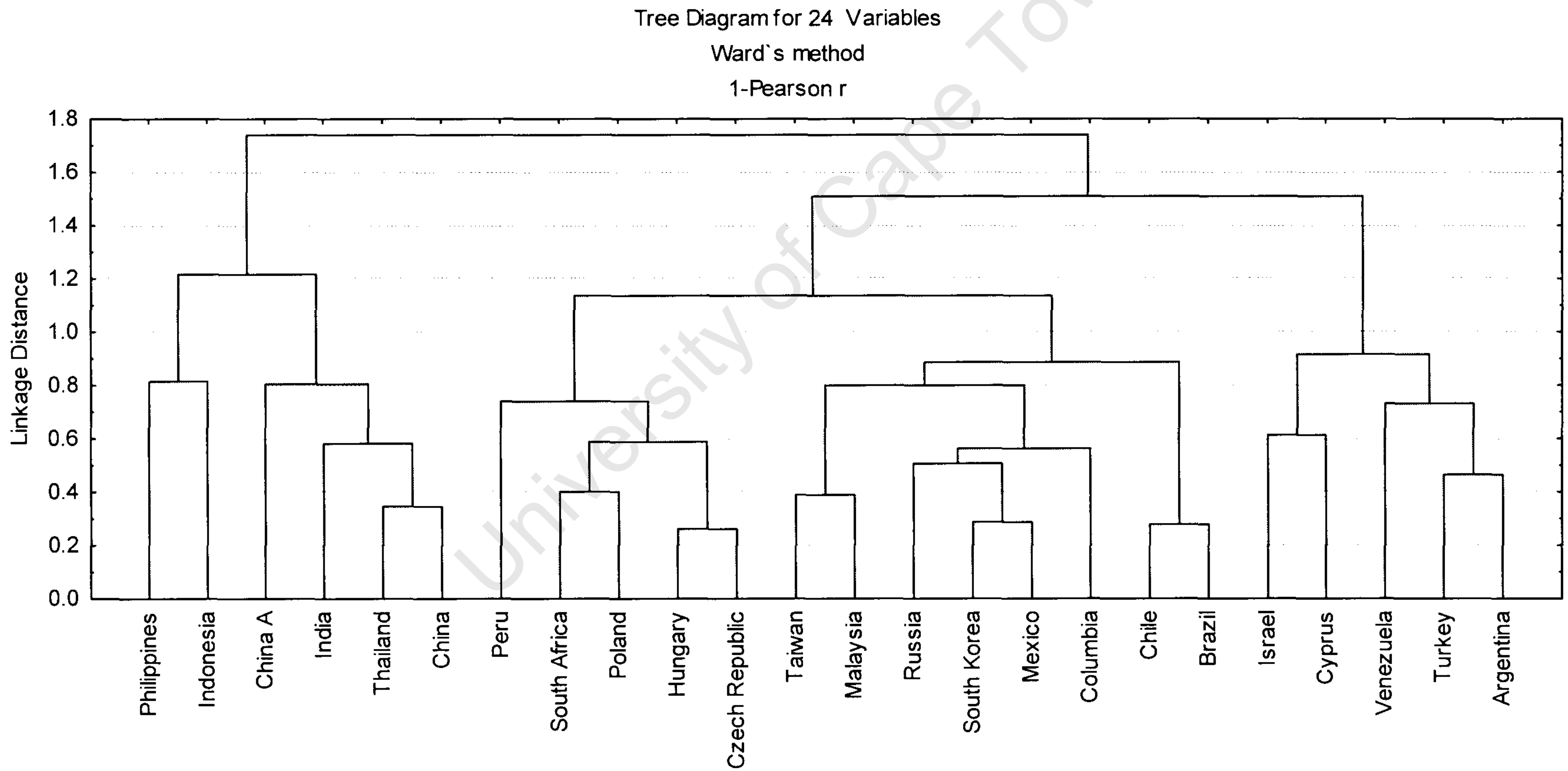
Appendix B.3: Cluster Analysis of 24 Developed Market Indices

The tree diagram displays the linkage distances and resultant clusters of the cluster analysis conducted on the times series of monthly returns derived from the 24 developed market indices over the out-sample period from 31 January 2002 to 31 December 2005.



Appendix B.4: Cluster Analysis of 24 Emerging Market Indices

The tree diagram displays the linkage distances and resultant clusters of the cluster analysis conducted on the times series of monthly returns derived from the 24 emerging market indices over the out-sample period from 31 January 2002 to 31 December 2005.



Appendix B.5: Un-Rotated Factor Loadings for 51 Market Indices

The table shows the results of the factor analysis conducted on the time series of monthly returns derived from the 51 market indices (48 countries and three FTSE indices covering the world, developed and emerging markets) using the principal components method. The factor loadings are un-rotated and the market indices displayed in descending order according to factor loading. The sample period is the out-sample period from 31 January 2002 to 31 December 2005.

Factor 1		Factor 2	
Market Index	**Loading**	**Market Index**	**Loading**
Indonesia	0.118	Indonesia	0.545
Philippines	-0.186	China	0.488
China A	-0.310	Malaysia	0.474
Venezuela	-0.319	India	0.454
Peru	-0.324	South Africa	0.339
Argentina	-0.390	Thailand	0.333
Japan	-0.435	Peru	0.331
Israel	-0.481	Philippines	0.325
China	-0.483	FTSE Emerging	0.313
Malaysia	-0.484	Taiwan	0.313
India	-0.524	Singapore	0.302
Cyprus	-0.525	Poland	0.299
Czech Republic	-0.531	Japan	0.267
Russia	-0.540	Czech Republic	0.263
Thailand	-0.547	Hungary	0.248
Columbia	-0.565	Russia	0.242
New Zealand	-0.574	Columbia	0.191
Hungary	-0.601	Hong Kong	0.180
South Africa	-0.612	South Korea	0.177
Taiwan	-0.612	Canada	0.163
Turkey	-0.612	New Zealand	0.147
Greece	-0.618	Greece	0.147
Singapore	-0.621	Australia	0.146
Austria	-0.646	Mexico	0.127
Poland	-0.695	China A	0.121
South Korea	-0.715	Turkey	0.084
Finland	-0.727	Austria	0.067
Hong Kong	-0.737	Venezuela	0.035
Luxembourg	-0.745	Norway	0.030
Brazil	-0.756	Argentina	-0.031
Denmark	-0.759	Chile	-0.035
Mexico	-0.766	Brazil	-0.048
Chile	-0.767	FTSE World	-0.130
Portugal	-0.795	Luxembourg	-0.142
Ireland	-0.827	Denmark	-0.148
Canada	-0.828	FTSE Developed	-0.161
Switzerland	-0.838	Netherlands	-0.183
Norway	-0.850	U.K.	-0.187
Belgium	-0.854	U.S.A.	-0.194
Italy	-0.855	Portugal	-0.214
Australia	-0.869	Spain	-0.222
U.S.A.	-0.871	Ireland	-0.225
Spain	-0.888	Switzerland	-0.225
Sweden	-0.889	Belgium	-0.236
FTSE Emerging	-0.896	Germany	-0.241
Germany	-0.917	France	-0.274
Netherlands	-0.918	Italy	-0.284
U.K.	-0.919	Sweden	-0.289
France	-0.930	Finland	-0.316
FTSE Developed	-0.946	Israel	-0.431
FTSE World	-0.953	Cyprus	-0.445
Explained Variance	**25.053**	**Explained Variance**	**3.507**
% of Total	**49.12%**	**% of Total**	**6.88%**
Cumulative %	**49.12%**	**Cumulative %**	**56.00%**

Appendix B.6: Varimax Rotated Factor Loadings for 51 Market Indices

The table shows the results of the factor analysis conducted on the time series of monthly returns derived from the 51 market indices (48 countries and three FTSE indices covering the world, developed and emerging markets) using the principal components method. The factor loadings are Varimax (raw and normalised) rotated and the market indices displayed in descending order according to factor loading. The sample period is the out-sample period from 31 January 2002 to 31 December 2005.

Varimax (Raw)

Factor 1		Factor 2	
Market Index	**Loading**	**Market Index**	**Loading**
France	0.955	FTSE Emerging	0.676
Germany	0.929	China	0.651
Sweden	0.925	India	0.639
FTSE Developed	0.920	Malaysia	0.639
FTSE World	0.913	Poland	0.576
U.K.	0.907	South Africa	0.574
Netherlands	0.905	Taiwan	0.551
Spain	0.894	Singapore	0.546
Italy	0.892	Thailand	0.540
Belgium	0.870	Australia	0.515
U.S.A.	0.867	Canada	0.512
Switzerland	0.851	Hungary	0.488
Ireland	0.841	Hong Kong	0.487
Portugal	0.808	South Korea	0.474
Finland	0.792	Czech Republic	0.470
Norway	0.749	Russia	0.455
Denmark	0.746	Mexico	0.452
Luxembourg	0.731	Peru	0.440
Australia	0.715	Indonesia	0.437
Chile	0.703	Japan	0.432
Brazil	0.699	Columbia	0.421
Canada	0.671	Greece	0.405
Cyprus	0.668	Norway	0.402
FTSE Emerging	0.665	New Zealand	0.386
Mexico	0.631	Philippines	0.373
Israel	0.622	Turkey	0.346
Hong Kong	0.582	Austria	0.345
South Korea	0.563	Chile	0.307
Austria	0.550	FTSE World	0.305
Turkey	0.512	Brazil	0.290
Poland	0.491	FTSE Developed	0.274
Greece	0.489	China A	0.246
New Zealand	0.450	Netherlands	0.242
Hungary	0.429	U.K.	0.238
Singapore	0.424	U.S.A.	0.211
Columbia	0.422	Denmark	0.202
Taiwan	0.411	Luxembourg	0.202
South Africa	0.399	Spain	0.193
Russia	0.378	Germany	0.189
Argentina	0.364	Venezuela	0.173
Czech Republic	0.360	Switzerland	0.168
Thailand	0.344	France	0.165
Japan	0.272	Belgium	0.165
Venezuela	0.271	Ireland	0.164
India	0.269	Portugal	0.159
China A	0.224	Argentina	0.144
Malaysia	0.224	Sweden	0.134
China	0.218	Italy	0.123
Peru	0.144	Finland	0.038
Philippines	0.023	Cyprus	-0.167
Indonesia	-0.347	Israel	-0.174
Explained Variance	**20.847**	**Explained Variance**	**7.713**
% of Total	**40.88%**	**% of Total**	**15.12%**
Cumulative %	**40.88%**	**Cumulative %**	**56.00%**

Varimax (Normalised)

Factor 1		Factor 2	
Market Index	**Loading**	**Market Index**	**Loading**
France	0.906	FTSE Emerging	0.791
Sweden	0.883	China	0.681
Germany	0.876	India	0.679
Italy	0.852	Malaysia	0.670
FTSE Developed	0.851	Poland	0.659
U.K.	0.845	Australia	0.642
Netherlands	0.842	South Africa	0.640
Spain	0.841	Canada	0.631
FTSE World	0.838	Taiwan	0.619
Belgium	0.823	Singapore	0.616
U.S.A.	0.811	Thailand	0.596
Switzerland	0.803	Hong Kong	0.589
Ireland	0.794	South Korea	0.573
Finland	0.770	Mexico	0.565
Portugal	0.763	Hungary	0.561
Denmark	0.694	Norway	0.538
Cyprus	0.688	Czech Republic	0.530
Luxembourg	0.679	Russia	0.519
Norway	0.658	Columbia	0.494
Israel	0.644	Greece	0.491
Chile	0.632	Japan	0.476
Brazil	0.631	FTSE World	0.474
Australia	0.603	New Zealand	0.465
Canada	0.561	Peru	0.459
Mexico	0.533	FTSE Developed	0.445
FTSE Emerging	0.524	Austria	0.444
Hong Kong	0.478	Turkey	0.438
Austria	0.474	Chile	0.436
South Korea	0.462	Brazil	0.419
Turkey	0.437	Netherlands	0.410
Greece	0.403	U.K.	0.407
Poland	0.372	U.S.A.	0.373
New Zealand	0.368	Philippines	0.371
Columbia	0.334	Germany	0.363
Argentina	0.330	Indonesia	0.363
Hungary	0.328	Spain	0.360
Singapore	0.312	France	0.345
Taiwan	0.298	Denmark	0.341
Russia	0.284	Luxembourg	0.338
South Africa	0.282	Belgium	0.328
Czech Republic	0.263	Switzerland	0.328
Thailand	0.234	Ireland	0.322
Venezuela	0.233	Portugal	0.310
Japan	0.185	Sweden	0.308
China A	0.173	Italy	0.291
India	0.142	China A	0.284
Malaysia	0.098	Venezuela	0.221
China	0.089	Argentina	0.211
Peru	0.058	Finland	0.189
Philippines	-0.049	Cyprus	-0.037
Indonesia	-0.424	Israel	-0.052
Explained Variance	**17.161**	**Explained Variance**	**11.399**
% of Total	**33.65%**	**% of Total**	**22.35%**
Cumulative %	**33.65%**	**Cumulative %**	**56.00%**

Appendix B.7: Promax Rotated Factor Loadings for 51 Market Indices

The table shows the results of the factor analysis conducted on the time series of monthly returns derived from the 51 market indices (48 countries and three FTSE indices covering the world, developed and emerging markets) using the principal components method. The factor loadings are Promax rotated and the market indices displayed in descending order according to factor loading. The sample period is the out-sample period from 31 January 2002 to 31 December 2005.

Factor 1		Factor 2	
Market Index	**Loading**	**Market Index**	**Loading**
France	0.902	China	0.788
Sweden	0.891	FTSE Emerging	0.773
Italy	0.864	Malaysia	0.772
Germany	0.858	India	0.767
Spain	0.820	South Africa	0.673
Cyprus	0.818	Poland	0.665
Finland	0.813	Taiwan	0.643
Belgium	0.812	Thailand	0.637
U.K.	0.802	Singapore	0.635
Netherlands	0.798	Indonesia	0.580
FTSE Developed	0.793	Australia	0.567
Switzerland	0.790	Canada	0.567
Ireland	0.782	Hungary	0.563
U.S.A.	0.779	Czech Republic	0.548
Israel	0.774	Hong Kong	0.546
FTSE World	0.765	Peru	0.532
Portugal	0.750	South Korea	0.532
Denmark	0.656	Russia	0.527
Luxembourg	0.641	Japan	0.509
Brazil	0.548	Mexico	0.497
Chile	0.541	Columbia	0.480
Norway	0.527	Philippines	0.462
Australia	0.416	Greece	0.453
Canada	0.372	New Zealand	0.433
Mexico	0.369	Norway	0.423
Austria	0.354	Turkey	0.377
Turkey	0.313	Austria	0.372
Hong Kong	0.293	Chile	0.309
Argentina	0.290	Brazil	0.289
South Korea	0.282	FTSE World	0.284
FTSE Emerging	0.256	China A	0.283
Greece	0.250	FTSE Developed	0.245
New Zealand	0.221	Netherlands	0.207
Venezuela	0.172	U.K.	0.202
Columbia	0.168	Venezuela	0.187
Poland	0.139	Luxembourg	0.175
Hungary	0.131	Denmark	0.174
China A	0.000	U.S.A.	0.172
Czech Republic	0.000	Spain	0.147
Japan	0.000	Argentina	0.142
Russia	0.000	Germany	0.139
Singapore	0.000	Switzerland	0.121
South Africa	0.000	Ireland	0.116
Taiwan	0.000	Belgium	0.115
Thailand	0.000	Portugal	0.113
India	-0.138	France	0.106
Peru	-0.138	Finland	0.000
Malaysia	-0.186	Italy	0.000
China	-0.201	Sweden	0.000
Philippines	-0.223	Cyprus	-0.278
Indonesia	-0.657	Israel	-0.282
Explained Variance	**14.782**	**Explained Variance**	**9.963**
% of Total	**29.00%**	**% of Total**	**19.50%**
Cumulative %	**29.00%**	**Cumulative %**	**48.50%**

Appendix C

Appendix C contains material associated with chapter 6: Sector-Specific Attribute Analysis.

Appendix C.1: Out-sample Cross-Sectional Regression Results using Single-Index Model Adjusted Data

The table shows the results of the univariate cross-sectional regression analyses for the Single-Index model adjusted returns against each sector-specific attribute over the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient, t-statistic, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given for each attribute. The attributes are sorted in descending order according to the absolute values of the t-statistics. Attributes which are significant at the 5% level of significance (two-tailed) have their t-statistics displayed in bold. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

Attribute	Mean Coefficient	T-Statistic	Mean Information Coefficient	Mean Information Ratio	Number of Observations in Final Month
C-12P	0.0026	**7.7660**	0.0397	1.0974	979
CP	0.0030	**7.6720**	0.0447	1.1097	997
C-24P	0.0030	**7.4312**	0.0476	1.1091	955
EY	0.0033	**6.9550**	0.0500	0.9987	1103
BP	0.0032	**6.5478**	0.0458	0.9104	1067
DY	0.0032	**5.5054**	0.0472	0.7962	1173
MOM-18	0.0042	**5.1464**	0.0657	0.8444	1140
D-24P	0.0025	**5.1396**	0.0389	0.7897	1123
D-12P	0.0019	**4.8035**	0.0293	0.7088	1152
MOM-12	0.0037	**4.4493**	0.0601	0.7201	1147
C-6P	0.0015	**4.1032**	0.0240	0.5513	983
PO	0.0017	**4.0483**	0.0242	0.5788	1169
E-24P	0.0018	**3.7418**	0.0285	0.5774	1020
CB	0.0010	**3.4211**	0.0159	0.5090	960
E-12P	0.0015	**3.1250**	0.0228	0.5011	1070
E-6P	0.0012	**2.9236**	0.0192	0.4361	1089
D-6P	0.0010	**2.6708**	0.0157	0.4163	1165
MVTMV-24	0.0012	**2.6677**	0.0204	0.4686	620
VO-12	0.0010	**2.4958**	0.0142	0.3567	573
MVTMV-12	0.0009	**2.4250**	0.0147	0.4056	573
LNMV	-0.0014	**-2.2901**	-0.0173	-0.2778	1201
ROE	0.0009	1.9299	0.0143	0.3027	1014
MOM-6	0.0014	1.9048	0.0274	0.3491	1174
DC	0.0009	1.8628	0.0151	0.2988	1058
MVTMV-3	0.0006	1.5298	0.0089	0.2265	929
SIGMA	-0.0012	-1.3313	-0.0116	-0.1342	1204
MOM-3	0.0010	1.2666	0.0181	0.2304	1163
MOM-1	0.0008	1.1283	0.0119	0.1743	1179
VO-24	0.0005	0.8735	0.0104	0.1913	619
MVTMV-1	0.0003	0.6921	0.0055	0.1116	930
MVTMV	-0.0003	-0.6267	-0.0039	-0.0763	960
VO-3	0.0002	0.4286	0.0027	0.0650	927
MVTMV-6	0.0001	0.3523	0.0028	0.0659	915
VO-6	0.0001	0.3309	0.0025	0.0571	913
VO-1	0.0000	0.0343	0.0009	0.0182	928

Appendix C.2: Out-sample Cross-Sectional Regression Results using Empirical ICAPM Adjusted Data

The table shows the results of the univariate cross-sectional regression analyses for the empirical ICAPM adjusted returns against each sector-specific attribute over the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient, t-statistic, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given for each attribute. The attributes are sorted in descending order according to the absolute values of the t-statistics. Attributes which are significant at the 5% level of significance (two-tailed) have their t-statistics displayed in bold. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

Attribute	Mean Coefficient	T-Statistic	Mean Information Coefficient	Mean Information Ratio	Number of Observations in Final Month
C-12P	0.0023	**7.8672**	0.0366	1.0645	979
CP	0.0030	**7.8370**	0.0472	1.1375	997
EY	0.0028	**6.7340**	0.0452	0.9500	1103
C-24P	0.0024	**6.6765**	0.0407	0.9936	955
BP	0.0029	**6.2855**	0.0450	0.8761	1067
DY	0.0028	**5.6061**	0.0442	0.8228	1173
D-24P	0.0021	**5.0105**	0.0342	0.7821	1123
MOM-18	0.0036	**4.7858**	0.0608	0.7874	1140
MOM-12	0.0033	**4.3284**	0.0568	0.7018	1147
D-12P	0.0016	**4.2038**	0.0260	0.6348	1152
PO	0.0014	**4.0799**	0.0220	0.6123	1169
CB	0.0011	**3.8159**	0.0182	0.5740	960
E-24P	0.0013	**3.2221**	0.0231	0.5021	1020
C-6P	0.0013	**3.2123**	0.0211	0.4457	983
MVTMV-24	0.0011	**2.7020**	0.0203	0.4579	620
E-6P	0.0010	**2.5591**	0.0172	0.3903	1089
D-6P	0.0009	**2.3414**	0.0148	0.3810	1165
E-12P	0.0010	**2.1983**	0.0159	0.3608	1070
MOM-6	0.0014	**2.0704**	0.0284	0.3768	1174
VO-12	0.0006	1.7459	0.0099	0.2457	573
DC	0.0007	1.7163	0.0137	0.2961	1058
MVTMV-12	0.0006	1.5695	0.0106	0.2779	573
ROE	0.0006	1.3712	0.0111	0.2249	1014
LNMV	-0.0007	-1.3676	-0.0093	-0.1622	1201
MOM-1	0.0008	1.1263	0.0141	0.1900	1179
MOM-3	0.0007	1.0128	0.0158	0.2049	1163
VO-24	0.0005	0.9054	0.0105	0.1855	619
MVTMV-3	0.0003	0.8830	0.0063	0.1436	929
MVTMV-1	0.0002	0.4881	0.0042	0.0833	930
MVTMV	-0.0002	-0.3594	-0.0030	-0.0542	960
MVTMV-6	0.0001	0.3309	0.0027	0.0637	915
SIGMA	-0.0002	-0.2668	-0.0006	-0.0072	1204
VO-1	-0.0001	-0.1380	-0.0004	-0.0087	928
VO-6	0.0000	0.1086	0.0009	0.0195	913
VO-3	0.0000	-0.0582	0.0004	0.0086	927

Appendix C.3: Out-sample Cross-Sectional Regression Results using Multi-Index Model Adjusted Data

The table shows the results of the univariate cross-sectional regression analyses for the Multi-Index model adjusted returns against each sector-specific attribute over the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient, t-statistic, mean monthly Information Coefficient, mean Information Ratio and number of observations in the final month are given for each attribute. The attributes are sorted in descending order according to the absolute values of the t-statistics. Attributes which are significant at the 5% level of significance (two-tailed) have their t-statistics displayed in bold. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

Attribute	Mean Coefficient	T-Statistic	Mean Information Coefficient	Mean Information Ratio	Number of Observations in Final Month
C-12P	0.0023	**6.6078**	0.0346	0.8992	979
C-24P	0.0027	**6.2649**	0.0422	0.9194	955
CP	0.0022	**5.6739**	0.0332	0.7773	997
DY	0.0032	**5.6161**	0.0486	0.7981	1173
EY	0.0027	**5.4535**	0.0399	0.7483	1103
BP	0.0025	**4.9312**	0.0351	0.6575	1067
PO	0.0019	**4.7184**	0.0285	0.6801	1169
D-24P	0.0022	**4.6471**	0.0348	0.7013	1123
MOM-18	0.0036	**4.5584**	0.0569	0.7489	1140
MOM-12	0.0034	**4.3716**	0.0550	0.7042	1147
D-12P	0.0017	**4.1547**	0.0259	0.6022	1152
C-6P	0.0013	**3.7207**	0.0205	0.4819	983
LNMV	-0.0019	**-3.4079**	-0.0270	-0.4628	1201
CB	0.0010	**3.3300**	0.0157	0.4943	960
SIGMA	-0.0027	**-3.2329**	-0.0400	-0.4980	1204
E-24P	0.0013	**2.8966**	0.0203	0.4222	1020
MVTMV-12	0.0009	**2.7499**	0.0149	0.4228	573
MVTMV-24	0.0010	**2.5932**	0.0179	0.4179	620
E-12P	0.0012	**2.5504**	0.0181	0.3975	1070
DC	0.0012	**2.5159**	0.0202	0.3910	1058
ROE	0.0009	**2.1085**	0.0154	0.3196	1014
VO-12	0.0008	**2.0644**	0.0125	0.2908	573
D-6P	0.0007	**2.0285**	0.0113	0.2979	1165
E-6P	0.0007	1.7431	0.0108	0.2514	1089
MOM-6	0.0012	1.6003	0.0243	0.3060	1174
MOM-3	0.0011	1.5610	0.0202	0.2828	1163
MVTMV	-0.0008	-1.5077	-0.0109	-0.2184	960
MVTMV-1	0.0004	1.0858	0.0065	0.1548	930
MVTMV-3	0.0003	0.6416	0.0046	0.1036	929
MOM-1	0.0004	0.5784	0.0065	0.0999	1179
MVTMV-6	0.0001	0.4236	0.0034	0.0849	915
VO-6	0.0001	0.3909	0.0030	0.0728	913
VO-24	0.0002	0.3254	0.0052	0.0960	619
VO-1	0.0001	0.2651	0.0022	0.0476	928
VO-3	-0.0001	-0.2286	-0.0009	-0.0178	927

Appendix C.4: Unadjusted Cross-Sectional Regression Results Averaged Yearly

The table shows the results of the univariate cross-sectional regression analyses for the unadjusted returns against each sector-specific attribute over the in-sample period from 31 January 1995 to 31 December 2001 and the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient and t-statistic are given for each attribute on a yearly basis. The attributes are displayed in style group order. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

		In-Sample								Out-Sample (Unadjusted)				
		1995	1996	1997	1998	1999	2000	2001	ALL	2002	2003	2004	2005	ALL
Value	BP													
	Mean Slope	-0.0011	0.0002	-0.0051	-0.0068	0.0035	0.0043	0.0070	0.0003	0.0062	0.0044	0.0040	-0.0005	0.0036
	T-Statistic	-0.6244	0.1878	-1.7852	-1.8779	0.9610	1.9544	2.6111	0.2729	4.1196	3.7205	3.2866	-0.4428	5.1263
	CP													
	Mean Slope	0.0004	0.0000	0.0012	-0.0018	0.0026	0.0045	0.0080	0.0021	0.0043	0.0057	0.0049	0.0011	0.0041
	T-Statistic	0.2063	0.0349	0.7568	-0.6086	1.0246	1.6856	3.5337	2.4219	3.1426	3.5666	4.3519	0.9596	5.8601
	DY													
	Mean Slope	0.0040	0.0032	0.0005	-0.0010	-0.0016	0.0091	0.0059	0.0029	0.0055	0.0025	0.0047	-0.0002	0.0032
	T-Statistic	2.6061	1.8446	0.2906	-0.5128	-0.6759	3.9758	3.4377	3.5749	3.9443	1.8410	3.9457	-0.2357	4.6865
	EY													
	Mean Slope	0.0021	0.0031	-0.0013	-0.0053	0.0007	0.0041	0.0084	0.0017	0.0052	0.0045	0.0055	0.0000	0.0039
	T-Statistic	1.5638	2.3211	-0.4242	-1.5438	0.3997	1.7254	3.4808	1.7443	3.1353	3.3743	6.3163	0.0109	5.5735
Growth	C-6P													
	Mean Slope	0.0016	0.0020	0.0052	0.0033	0.0033	-0.0009	0.0005	0.0022	0.0012	0.0014	0.0028	-0.0009	0.0012
	T-Statistic	1.0497	3.2007	3.0584	1.2171	1.6740	-0.7255	0.3210	3.2834	0.8707	1.5920	3.9039	-1.0457	2.3003
	C-12P													
	Mean Slope	0.0018	0.0041	0.0038	0.0026	0.0020	0.0016	0.0015	0.0025	0.0042	0.0040	0.0035	0.0011	0.0032
	T-Statistic	1.2485	4.0613	3.0177	0.6943	1.0252	1.4384	0.9199	3.4618	6.5743	4.7214	4.0526	0.9047	6.8925
	C-24P													
	Mean Slope	0.0005	0.0045	0.0002	0.0037	-0.0016	0.0016	0.0009	0.0014	0.0051	0.0028	0.0043	0.0029	0.0038
	T-Statistic	0.3521	5.2341	0.3310	1.1253	-0.5884	1.0348	0.5722	1.9010	2.9677	2.4936	4.6482	1.9152	5.6779
	CB													
	Mean Slope	0.0040	-0.0016	0.0037	0.0068	-0.0019	0.0007	0.0017	0.0019	0.0011	0.0024	0.0017	0.0006	0.0015
	T-Statistic	4.5919	-1.7441	1.4363	2.3830	-0.8205	0.6115	1.5905	2.5450	0.7989	2.6362	1.9771	0.7632	2.9379
	DC													
	Mean Slope	0.0021	0.0004	0.0002	0.0002	-0.0019	0.0060	0.0010	0.0011	0.0017	-0.0021	0.0015	-0.0009	0.0001
	T-Statistic	1.1119	0.2139	0.1584	0.0775	-1.1173	2.9171	0.7325	1.5692	1.9808	-1.4985	2.5233	-0.7769	0.1547
	D-6P													
	Mean Slope	-0.0002	0.0013	0.0053	0.0023	-0.0009	-0.0028	0.0009	0.0008	0.0019	-0.0006	0.0006	0.0013	0.0008
	T-Statistic	-0.1249	0.8497	2.6107	0.8726	-0.5344	-3.1789	0.9018	1.2728	1.5932	-0.6458	0.8089	2.0890	1.6494
	D-12P													
	Mean Slope	0.0023	0.0040	0.0038	0.0018	-0.0002	-0.0002	0.0006	0.0017	0.0027	0.0003	0.0030	0.0012	0.0018
	T-Statistic	2.0290	5.0795	2.8351	0.4601	-0.0830	-0.2343	0.5727	2.3849	1.9465	0.3309	4.2935	1.5387	3.5264
	D-24P													
	Mean Slope	0.0025	0.0024	0.0041	0.0019	-0.0023	0.0005	0.0025	0.0017	0.0038	-0.0009	0.0046	0.0010	0.0021
	T-Statistic	2.0618	2.0973	3.4045	0.6067	-0.7463	0.3490	2.0932	2.2488	2.4953	-0.9034	4.6179	1.4638	3.3675
	E-6P													
	Mean Slope	-0.0011	0.0026	0.0045	0.0031	-0.0027	-0.0015	0.0010	0.0009	0.0016	0.0011	0.0017	0.0012	0.0014
	T-Statistic	-1.0207	2.5300	2.6164	1.0491	-1.4665	-1.0057	0.6068	1.2146	0.9906	1.2516	2.3787	0.7985	2.3860
	E-12P													
	Mean Slope	0.0006	0.0024	0.0029	0.0010	-0.0030	-0.0012	0.0004	0.0004	0.0041	0.0008	0.0022	0.0013	0.0021
	T-Statistic	0.4618	1.9617	2.1147	0.2212	-1.1467	-0.8222	0.2269	0.5114	2.2713	0.6947	3.6543	0.8607	3.1505
	E-24P													
	Mean Slope	0.0011	0.0011	0.0035	0.0011	-0.0038	-0.0016	0.0017	0.0004	0.0035	-0.0006	0.0041	0.0014	0.0021
	T-Statistic	0.9098	0.8699	1.5943	0.4223	-1.2212	-1.3311	1.3815	0.5801	1.5491	-0.5558	5.5536	1.0357	2.8069
	PO													
	Mean Slope	0.0022	0.0009	0.0004	0.0027	0.0013	0.0028	0.0007	0.0016	0.0028	0.0000	0.0018	-0.0004	0.0011
	T-Statistic	1.4975	0.5214	0.2197	1.9638	0.6755	1.5158	0.6735	2.6498	3.1208	-0.0198	2.2467	-0.4470	2.3973
	ROE													
	Mean Slope	0.0021	0.0029	0.0029	0.0031	-0.0027	0.0010	0.0018	0.0016	0.0006	0.0005	0.0018	0.0001	0.0008
	T-Statistic	1.7484	2.0213	1.7016	1.1333	-1.2352	1.0668	1.3955	2.3776	0.3712	0.4767	1.7430	0.1471	1.2903

Appendix C.4: Unadjusted Cross-Sectional Regression Results Averaged Yearly

-continued.

		In-Sample								Out-Sample (Unadjusted)				
		1995	1996	1997	1998	1999	2000	2001	ALL	2002	2003	2004	2005	ALL
Momentum	MOM-1													
	Mean Slope	-0.0005	0.0039	0.0036	0.0046	0.0055	0.0005	0.0021	0.0028	0.0006	0.0003	0.0016	-0.0011	0.0004
	T-Statistic	-0.2169	2.5474	1.7284	1.2755	1.2830	0.1198	0.5304	2.2725	0.1595	0.1433	1.2826	-0.5145	0.3197
	MOM-3													
	Mean Slope	0.0017	0.0037	0.0101	0.0039	0.0019	0.0040	0.0009	0.0038	0.0031	-0.0003	0.0017	0.0008	0.0013
	T-Statistic	1.1310	1.4445	2.6188	0.8108	0.3850	0.7461	0.2169	2.4512	0.9045	-0.1025	1.1175	0.4156	1.0601
	MOM-6													
	Mean Slope	0.0021	0.0041	0.0121	0.0080	0.0053	0.0025	0.0062	0.0058	0.0022	0.0013	0.0020	0.0035	0.0022
	T-Statistic	1.3182	2.0856	3.7748	1.1147	1.2109	0.4235	1.2709	3.3814	0.5101	0.6042	1.1744	1.5585	1.6287
	MOM-12													
	Mean Slope	0.0050	0.0066	0.0127	0.0128	0.0030	-0.0058	0.0080	0.0061	0.0080	-0.0003	0.0034	0.0050	0.0040
	T-Statistic	2.6986	3.9100	4.3091	1.9540	0.6158	-1.6672	1.6848	3.7272	2.2025	-0.0913	1.7425	2.4991	2.7260
	MOM-18													
	Mean Slope	0.0013	0.0047	0.0112	0.0098	-0.0043	-0.0090	0.0005	0.0020	0.0073	-0.0010	0.0043	0.0047	0.0038
	T-Statistic	0.6008	1.9568	4.2799	1.7276	-0.8136	-3.0622	0.1129	1.2872	1.6012	-0.4349	2.6569	2.2290	2.5816
Size & Liquidity	LNMV													
	Mean Slope	0.0034	-0.0012	0.0001	0.0003	0.0071	0.0022	-0.0019	0.0014	-0.0039	-0.0010	-0.0015	0.0028	-0.0010
	T-Statistic	2.0036	-0.5425	0.0485	0.1225	2.5680	0.8698	-0.8939	1.5324	-2.0897	-0.5290	-0.8083	1.6663	-1.0231
	MVTMV													
	Mean Slope	0.0014	-0.0014	0.0017	-0.0034	0.0032	-0.0035	-0.0005	-0.0003	0.0250	-0.0003	0.0016	-0.0006	0.0066
	T-Statistic	0.7162	-1.2154	1.0673	-1.9222	0.9720	-1.5053	-0.1759	-0.4070	0.9149	-0.1879	1.3050	-0.5151	0.9418
	MVTMV-1													
	Mean Slope	-0.0009	0.0019	-0.0004	0.0015	0.0050	-0.0008	0.0007	0.0010	0.0016	-0.0002	0.0010	-0.0001	0.0006
	T-Statistic	-0.5335	1.7447	-0.1911	0.9612	1.7359	-0.5288	0.3749	1.3776	1.0558	-0.1847	0.9363	-0.1007	1.0124
	MVTMV-3													
	Mean Slope	0.0000	0.0015	-0.0009	0.0005	0.0051	0.0014	0.0003	0.0011	0.0022	-0.0001	0.0001	-0.0003	0.0005
	T-Statistic	0.0032	1.2687	-0.6662	0.4889	2.2076	0.8165	0.2704	1.7852	1.3108	-0.1204	0.0974	-0.4124	0.8240
	MVTMV-6													
	Mean Slope	-0.0008	0.0019	-0.0002	0.0019	0.0043	0.0018	-0.0006	0.0012	0.0006	-0.0001	0.0000	0.0014	0.0004
	T-Statistic	-0.5382	2.1190	-0.0977	0.8993	1.1397	1.1343	-0.4417	1.5404	0.6245	-0.0936	0.0128	1.8594	0.9260
	MVTMV-12													
	Mean Slope	0.0014	0.0019	0.0028	0.0002	0.0016	-0.0026	-0.0003	0.0007	0.0005	-0.0011	0.0012	0.0011	0.0004
	T-Statistic	1.2953	1.4774	1.4001	0.1381	0.6152	-1.7050	-0.2869	1.1632	0.3934	-1.2293	2.3027	1.5793	0.9330
	MVTMV-24													
	Mean Slope	0.0022	0.0019	0.0023	0.0016	0.0059	-0.0022	-0.0008	0.0016	0.0016	0.0014	-0.0008	0.0006	0.0007
	T-Statistic	0.9773	1.4576	1.3716	0.7100	2.1190	-0.9729	-0.5230	1.9627	1.2511	1.6036	-0.6204	1.0191	1.2785
	VO-1													
	Mean Slope	-0.0010	0.0017	-0.0002	0.0013	0.0051	-0.0007	0.0008	0.0010	0.0016	-0.0018	0.0005	-0.0001	0.0001
	T-Statistic	-0.6379	1.7022	-0.1110	0.7798	1.7081	-0.4732	0.4312	1.3637	0.9335	-1.3000	0.5555	-0.1447	0.1062
	VO-3													
	Mean Slope	-0.0001	0.0018	-0.0011	0.0007	0.0044	0.0013	-0.0005	0.0009	0.0016	-0.0004	-0.0009	-0.0004	0.0000
	T-Statistic	-0.0407	1.4439	-0.7549	0.5248	2.0465	0.6845	-0.3931	1.4334	0.9366	-0.3870	-1.1008	-0.4466	-0.0200
	VO-6													
	Mean Slope	-0.0005	0.0018	-0.0003	0.0029	0.0049	0.0009	-0.0008	0.0013	0.0004	-0.0002	-0.0002	0.0014	0.0003
	T-Statistic	-0.4826	2.0428	-0.2024	1.3690	1.2000	0.5745	-0.5832	1.6218	0.4877	-0.1812	-0.1948	1.8073	0.6928
	VO-12													
	Mean Slope	0.0021	0.0013	0.0041	0.0006	0.0025	-0.0017	-0.0008	0.0011	0.0014	-0.0010	0.0008	-0.0001	0.0003
	T-Statistic	1.6126	1.3924	1.8988	0.4101	0.9113	-1.1312	-0.5995	1.7187	1.1580	-1.2598	1.1738	-0.1272	0.6630
	VO-24													
	Mean Slope	0.0007	0.0017	0.0026	0.0009	0.0060	-0.0027	-0.0007	0.0012	-0.0003	0.0008	-0.0008	-0.0003	-0.0001
	T-Statistic	0.3235	1.5539	1.5041	0.4466	2.4204	-1.1156	-0.4306	1.5572	-0.2187	1.0448	-0.8401	-0.2556	-0.2521
Risk	SIGMA													
	Mean Slope	-0.0037	0.0000	-0.0087	-0.0074	0.0086	-0.0131	-0.0011	-0.0036	-0.0058	0.0074	0.0000	0.0039	0.0014
	T-Statistic	-1.4071	-0.0003	-2.7831	-1.0490	1.4730	-3.6171	-0.1854	-1.9544	-1.1457	2.3271	0.0302	1.2838	0.7471

Appendix C.5: Risk-Adjusted Cross-Sectional Regression Results Averaged Yearly

The table shows the results of the univariate cross-sectional regression analyses for the risk-adjusted returns against each sector-specific attribute over the out-sample period from 31 January 2002 to 31 December 2005. The mean regression coefficient and t-statistic are given for each attribute on a yearly basis. The attributes are displayed in style group order. The data was obtained from Datastream International at the University of Cape Town and is adjusted for outliers by double winsorisation, with the returns data also being limited to 100% and the attribute data being standardised.

		Out-Sample (Single-Index Adjusted)					Out-Sample (ICAPM Adjusted)					Out-Sample (Multi-Index Adjusted)				
		2002	2003	2004	2005	ALL	2002	2003	2004	2005	ALL	2002	2003	2004	2005	ALL
Value	BP															
	Mean Slope	0.0051	0.0043	0.0031	-0.0002	0.0032	0.0046	0.0040	0.0030	-0.0002	0.0023	0.0043	0.0038	0.0025	-0.0010	0.0025
	T-Statistic	4.5909	9.0442	3.8272	-0.3849	6.5478	4.1376	8.1596	3.6855	-0.4159	6.2855	3.6373	6.0076	3.2785	-1.9011	4.9312
	CP															
	Mean Slope	0.0046	0.0034	0.0032	0.0004	0.0030	0.0047	0.0035	0.0033	0.0003	0.0032	0.0037	0.0026	0.0026	-0.0004	0.0022
	T-Statistic	5.9052	5.6148	4.9635	0.7866	7.6720	6.4238	5.5382	6.1244	0.4875	7.8370	5.2252	4.4613	3.7117	-0.6760	5.6739
	DY															
	Mean Slope	0.0042	0.0031	0.0053	-0.0001	0.0032	0.0029	0.0026	0.0050	0.0003	0.0030	0.0042	0.0032	0.0054	-0.0001	0.0032
	T-Statistic	3.6322	2.3836	5.4300	-0.2024	5.5054	2.9593	2.3650	5.6764	1.1720	5.6061	3.7797	2.4943	5.7130	-0.3131	5.6161
	EY															
	Mean Slope	0.0047	0.0035	0.0051	-0.0002	0.0033	0.0033	0.0033	0.0049	-0.0004	0.0028	0.0045	0.0030	0.0043	-0.0014	0.0027
	T-Statistic	4.8432	4.3064	8.3843	-0.3318	6.9550	4.1873	4.4931	10.2813	-0.8760	6.7340	4.7976	3.9712	6.9705	-2.4339	5.4535
Growth	C-6P															
	Mean Slope	0.0016	0.0012	0.0030	0.0002	0.0015	0.0007	0.0013	0.0032	-0.0002	0.0018	0.0014	0.0013	0.0028	-0.0003	0.0013
	T-Statistic	2.1308	1.6310	5.9469	0.2083	4.1032	0.8199	1.7612	6.9054	-0.1993	3.2123	2.1487	1.7183	5.7575	-0.4395	3.7207
	C-12P															
	Mean Slope	0.0039	0.0026	0.0030	0.0007	0.0026	0.0029	0.0022	0.0031	0.0007	0.0028	0.0035	0.0026	0.0027	0.0001	0.0023
	T-Statistic	6.0605	4.0836	5.6802	1.2670	7.7660	5.5810	4.8161	5.8610	1.1991	7.8672	4.9356	4.2499	5.2978	0.2113	6.6078
	C-24P															
	Mean Slope	0.0034	0.0031	0.0038	0.0015	0.0030	0.0021	0.0025	0.0037	0.0013	0.0025	0.0033	0.0030	0.0036	0.0005	0.0027
	T-Statistic	3.4309	3.5576	5.4710	3.5993	7.4312	2.4165	3.2263	5.4824	3.6373	6.6765	3.5243	3.1551	5.2033	1.2128	6.2649
	CB															
	Mean Slope	0.0015	0.0010	0.0010	0.0005	0.0010	0.0017	0.0013	0.0012	0.0003	0.0015	0.0018	0.0010	0.0009	0.0003	0.0010
	T-Statistic	2.0401	1.7149	1.7079	1.1459	3.4211	2.1210	2.0734	2.4366	0.8455	3.8159	2.2012	1.7410	1.6500	0.7542	3.3300
	DC															
	Mean Slope	0.0009	0.0002	0.0024	0.0001	0.0009	0.0001	-0.0001	0.0021	0.0007	0.0007	0.0011	0.0005	0.0028	0.0004	0.0012
	T-Statistic	1.2392	0.1039	3.9401	0.1010	1.8628	0.2023	-0.1052	3.9305	1.1055	1.7163	1.5322	0.3545	4.2563	0.6037	2.5159
	D-6P															
	Mean Slope	0.0012	0.0007	0.0014	0.0007	0.0010	0.0006	0.0006	0.0017	0.0007	0.0010	0.0008	0.0008	0.0012	0.0001	0.0007
	T-Statistic	1.3698	0.6830	2.0870	1.6542	2.6708	0.6066	0.6397	2.8585	1.6966	2.3414	1.0669	0.8538	1.6135	0.3178	2.0285
	D-12P															
	Mean Slope	0.0024	0.0012	0.0033	0.0006	0.0019	0.0014	0.0012	0.0032	0.0005	0.0017	0.0021	0.0011	0.0033	0.0001	0.0017
	T-Statistic	2.5791	1.5145	4.6141	1.2706	4.8035	1.4898	1.5583	4.8290	1.2624	4.2038	2.4885	1.2656	4.6130	0.1382	4.1547
	D-24P															
	Mean Slope	0.0032	0.0013	0.0046	0.0009	0.0025	0.0017	0.0011	0.0044	0.0010	0.0020	0.0030	0.0011	0.0044	0.0003	0.0022
	T-Statistic	2.7232	1.1239	7.6974	2.0962	5.1396	1.6804	1.2808	9.8497	2.5785	5.0105	2.7170	0.9808	8.1412	0.8290	4.6471
	E-6P															
	Mean Slope	0.0006	0.0015	0.0014	0.0013	0.0012	0.0001	0.0014	0.0017	0.0009	0.0013	0.0006	0.0009	0.0009	0.0004	0.0007
	T-Statistic	0.5345	2.1194	2.2921	1.6708	2.9236	0.0466	2.0215	2.6668	1.3760	2.5591	0.5089	1.1902	1.5083	0.5829	1.7431
	E-12P															
	Mean Slope	0.0021	0.0010	0.0018	0.0010	0.0015	0.0010	0.0006	0.0018	0.0005	0.0012	0.0022	0.0008	0.0015	0.0002	0.0012
	T-Statistic	1.3794	1.2409	2.7242	2.1733	3.1250	0.7085	0.7572	3.3942	1.3177	2.1983	1.5034	0.8911	2.5351	0.5182	2.5504
	E-24P															
	Mean Slope	0.0018	0.0011	0.0034	0.0006	0.0018	0.0005	0.0005	0.0037	0.0006	0.0014	0.0019	0.0012	0.0024	-0.0003	0.0013
	T-Statistic	1.7948	0.8692	6.3313	1.0366	3.7418	0.5484	0.6031	7.2251	1.0319	3.2221	1.9560	0.9637	3.8303	-0.6169	2.8966
	PO															
	Mean Slope	0.0026	0.0013	0.0025	0.0000	0.0017	0.0018	0.0010	0.0022	0.0005	0.0014	0.0027	0.0014	0.0029	0.0003	0.0019
	T-Statistic	2.8097	1.7361	3.2727	0.0597	4.0483	2.1378	1.5357	3.3653	1.0232	4.0799	2.9125	1.9227	4.2371	0.5415	4.7184
	ROE															
	Mean Slope	0.0004	0.0005	0.0022	0.0003	0.0009	-0.0004	0.0004	0.0021	0.0002	0.0011	0.0008	0.0008	0.0022	-0.0001	0.0009
	T-Statistic	0.3330	0.5654	3.1667	0.4639	1.9299	-0.3442	0.5666	3.9792	0.3246	1.3712	0.6577	0.9296	3.0812	-0.1511	2.1085

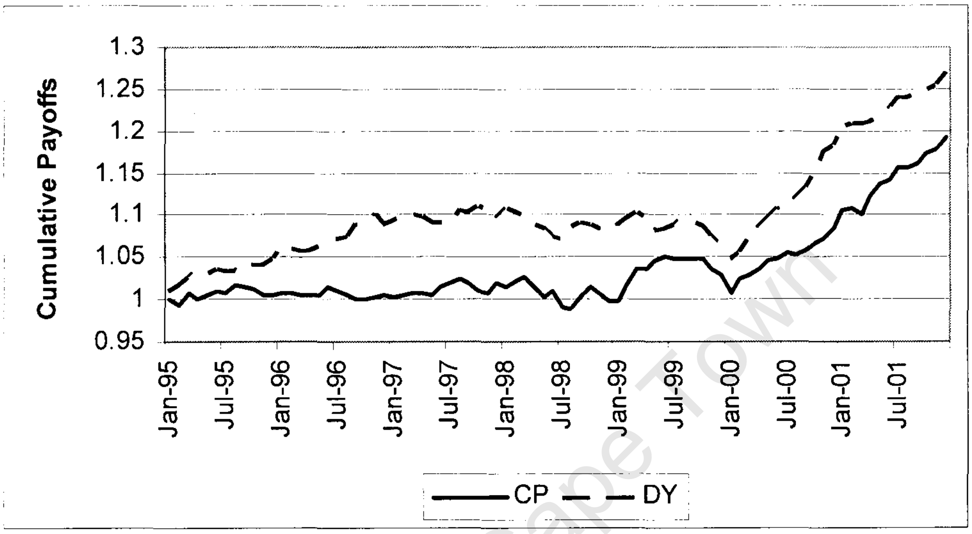
Appendix C.5: Risk-Adjusted Cross-Sectional Regression Results Averaged Yearly

-continued.

		Out-Sample (Single-Index Adjusted)					Out-Sample (ICAPM Adjusted)					Out-Sample (Multi-Index Adjusted)				
		2002	2003	2004	2005	ALL	2002	2003	2004	2005	ALL	2002	2003	2004	2005	ALL
Momentum	MOM-1															
	Mean Slope	0.0021	-0.0008	0.0008	0.0010	0.0008	0.0008	-0.0005	0.0018	0.0012	0.0019	0.0014	-0.0015	0.0006	0.0011	0.0004
	T-Statistic	1.1481	-0.4641	0.8497	1.2694	1.1283	0.4027	-0.3435	1.6336	1.4324	1.1263	0.8452	-1.0477	0.5609	1.6441	0.5784
	MOM-3															
	Mean Slope	0.0020	-0.0019	0.0015	0.0027	0.0010	0.0006	-0.0023	0.0020	0.0029	0.0026	0.0015	-0.0013	0.0024	0.0020	0.0011
	T-Statistic	0.8799	-1.2056	1.2553	4.8210	1.2666	0.2829	-1.8979	1.8379	5.1351	1.0128	0.6773	-0.9083	2.9258	3.3273	1.5610
	MOM-6															
	Mean Slope	0.0002	-0.0020	0.0029	0.0046	0.0014	-0.0002	-0.0016	0.0033	0.0044	0.0039	-0.0003	-0.0018	0.0034	0.0037	0.0012
	T-Statistic	0.1407	-1.7424	2.0654	7.7817	1.9048	-0.1645	-1.2627	2.8514	8.0759	2.0704	-0.1646	-1.4654	2.5714	6.1347	1.6003
	MOM-12															
	Mean Slope	0.0048	0.0008	0.0038	0.0056	0.0037	0.0034	0.0004	0.0038	0.0058	0.0050	0.0038	0.0014	0.0038	0.0047	0.0034
	T-Statistic	1.9900	0.5999	2.5729	7.5517	4.4493	1.6165	0.3243	2.8076	8.9744	4.3284	1.6366	1.0787	2.8623	6.0009	4.3716
	MOM-18															
	Mean Slope	0.0052	0.0027	0.0035	0.0054	0.0042	0.0033	0.0017	0.0038	0.0057	0.0033	0.0044	0.0026	0.0030	0.0045	0.0036
	T-Statistic	2.0472	1.8874	3.1630	6.1596	5.1464	1.4956	1.2045	3.9680	6.4540	4.7858	1.7494	1.7661	3.2119	4.9753	4.5584
Size & Liquidity	LNMV															
	Mean Slope	-0.0026	-0.0024	-0.0021	0.0019	-0.0014	-0.0009	-0.0016	-0.0018	0.0016	-0.0001	-0.0032	-0.0026	-0.0024	0.0008	-0.0019
	T-Statistic	-1.8631	-2.0682	-1.8849	3.6440	-2.2901	-0.6238	-1.5943	-2.4379	2.2580	-1.3676	-2.3406	-2.6166	-2.1527	1.6982	-3.4079
	MVTMV															
	Mean Slope	-0.0006	-0.0006	-0.0002	0.0001	-0.0003	0.0002	-0.0004	-0.0002	-0.0004	0.0015	-0.0011	-0.0011	-0.0004	-0.0005	-0.0008
	T-Statistic	-0.3979	-0.5034	-0.2127	0.0996	-0.6267	0.0973	-0.3410	-0.2261	-0.6906	-0.3594	-0.7876	-0.8491	-0.5690	-1.1243	-1.5077
	MVTMV-1															
	Mean Slope	0.0003	0.0007	0.0008	-0.0006	0.0003	0.0000	0.0006	0.0006	-0.0003	0.0008	0.0008	0.0007	0.0006	-0.0004	0.0004
	T-Statistic	0.2763	0.7191	0.8296	-0.7940	0.6921	-0.0371	0.6072	0.6146	-0.3763	0.4881	0.8115	0.9081	0.6807	-0.5708	1.0858
	MVTMV-3															
	Mean Slope	0.0008	0.0007	0.0005	0.0001	0.0006	0.0001	0.0005	0.0002	0.0005	0.0009	0.0002	0.0005	0.0002	0.0001	0.0003
	T-Statistic	1.1516	0.7879	1.0331	0.1209	1.5298	0.1588	0.6375	0.3443	0.6097	0.8830	0.2887	0.5436	0.2388	0.1245	0.6416
	MVTMV-6															
	Mean Slope	-0.0007	0.0010	-0.0004	0.0006	0.0001	-0.0008	0.0009	-0.0003	0.0007	0.0008	-0.0007	0.0008	-0.0003	0.0009	0.0001
	T-Statistic	-0.8536	1.2453	-0.5087	0.7911	0.3523	-0.9493	1.3506	-0.5149	1.0865	0.3309	-0.9062	1.1542	-0.5187	1.7454	0.4236
	MVTMV-12															
	Mean Slope	0.0009	0.0008	0.0007	0.0012	0.0009	0.0003	0.0005	0.0000	0.0015	0.0005	0.0011	0.0006	0.0004	0.0015	0.0009
	T-Statistic	0.7735	1.5349	1.1077	2.2403	2.4250	0.2806	1.0729	0.0336	3.4071	1.5695	1.2684	1.2295	0.5653	3.0393	2.7499
	MVTMV-24															
	Mean Slope	0.0005	0.0012	0.0009	0.0021	0.0012	0.0006	0.0011	0.0005	0.0024	0.0011	0.0008	0.0008	0.0003	0.0021	0.0010
	T-Statistic	0.4411	1.2527	1.6252	3.5025	2.6677	0.5874	1.0924	0.9800	4.7319	2.7020	0.9719	1.0134	0.4206	3.7301	2.5932
	VO-1															
	Mean Slope	0.0005	-0.0006	0.0008	-0.0008	0.0000	0.0003	-0.0007	0.0006	-0.0005	0.0006	0.0009	-0.0005	0.0005	-0.0005	0.0001
	T-Statistic	0.4168	-0.5341	0.8489	-0.9705	0.0343	0.2549	-0.7012	0.6631	-0.6446	-0.1380	0.7697	-0.4954	0.6233	-0.7174	0.2651
	VO-3															
	Mean Slope	0.0005	0.0001	0.0001	0.0000	0.0002	-0.0002	0.0000	-0.0002	0.0004	0.0005	-0.0003	0.0000	-0.0002	0.0002	-0.0001
	T-Statistic	0.5461	0.1717	0.1335	-0.0506	0.4286	-0.2011	-0.0436	-0.3146	0.4500	-0.0582	-0.2753	-0.0332	-0.2949	0.1733	-0.2286
	VO-6															
	Mean Slope	-0.0002	0.0009	-0.0007	0.0006	0.0001	-0.0003	0.0007	-0.0008	0.0007	0.0008	-0.0003	0.0007	-0.0006	0.0009	0.0001
	T-Statistic	-0.2779	0.9565	-1.1044	0.8786	0.3309	-0.3007	0.8617	-1.2349	0.9705	0.1086	-0.3877	0.8273	-0.9522	1.7264	0.3909
	VO-12															
	Mean Slope	0.0016	0.0011	0.0000	0.0011	0.0010	0.0011	0.0009	-0.0006	0.0012	0.0007	0.0016	0.0008	-0.0005	0.0014	0.0008
	T-Statistic	1.8226	1.5491	-0.0477	2.1444	2.4958	1.2276	1.5359	-0.7052	2.3880	1.7459	1.8735	1.0183	-0.4861	2.8799	2.0644
	VO-24															
	Mean Slope	-0.0010	0.0002	0.0008	0.0020	0.0005	-0.0008	0.0001	0.0004	0.0023	0.0006	-0.0009	-0.0003	0.0001	0.0018	0.0002
	T-Statistic	-0.6930	0.3206	1.0716	1.9709	0.8735	-0.5856	0.1283	0.5485	2.5350	0.9054	-0.6941	-0.3885	0.1452	1.8909	0.3254
Risk	SIGMA															
	Mean Slope	-0.0020	-0.0029	-0.0024	0.0031	-0.0012	0.0010	-0.0018	-0.0023	0.0025	-0.0016	-0.0028	-0.0036	-0.0043	0.0000	-0.0027
	T-Statistic	-0.7661	-2.3185	-2.0099	3.8017	-1.3313	0.4753	-2.3715	-1.6564	3.8036	-0.2668	-1.0330	-2.3747	-4.3787	0.0554	-3.2329

Appendix C.6.1: In-Sample Cumulative Monthly Payoffs to Value Style Attributes

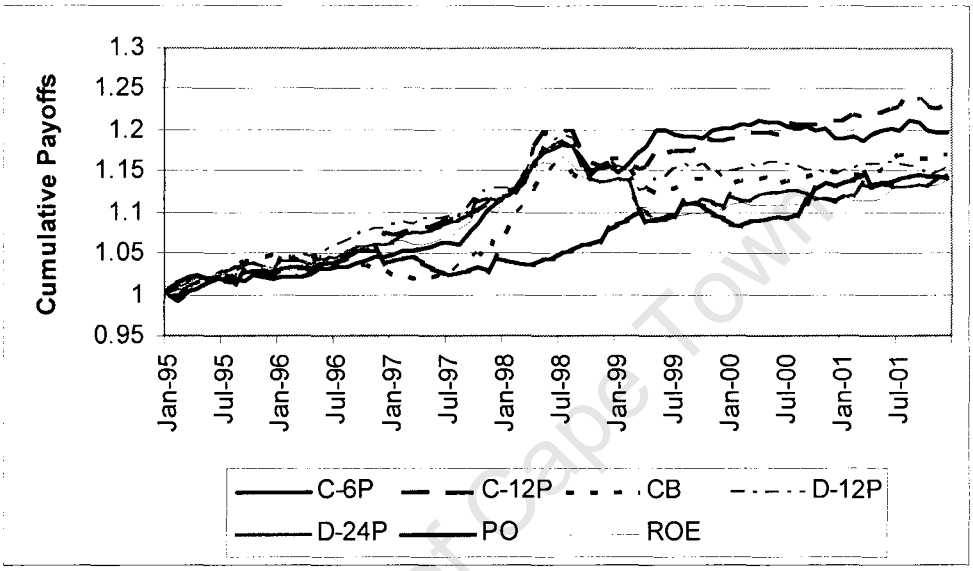
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'value' style group. The table shows the cumulative payoffs as at the end of the in-sample period: 31 December 2001. The attributes are cash earnings per share to price (CP) and dividend yield (DY), both of which are significant at the 5% level over the in-sample period, from 31 January 1995 to 31 December 2001, in the cross-sectional OLS regression tests on the unadjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
DY	Dividend Yield	26.85%
CP	Cash Earnings per Share to Price	19.29%

Appendix C.6.2: In-Sample Cumulative Monthly Payoffs to Growth Style Attributes

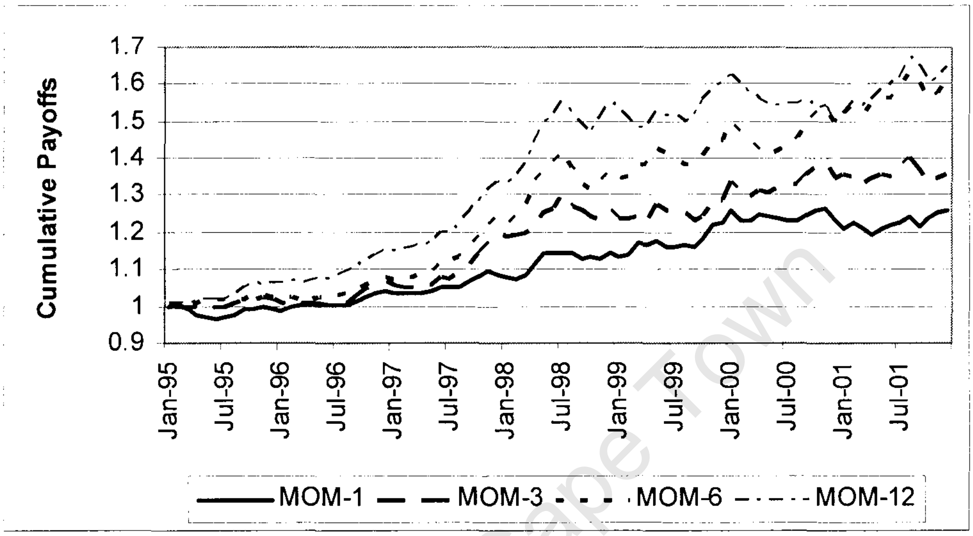
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'growth' style group. The table shows the cumulative payoffs as at the end of the in-sample period: 31 December 2001. The attributes are 6 and 12-month growth in cash earnings, to price (C-6P & C-12P), cash earnings to book value (CB), 12 and 24-month growth in dividends, to price (D-12P & D-24P), payout ratio (PO) and return on equity (ROE), all of which are significant at the 5% level over the in-sample period, from 31 January 1995 to 31 December 2001, in the cross-sectional OLS regression tests on the unadjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
C-12P	12-month growth in Cash Earnings, to Price	23.24%
C-6P	6-month growth in Cash Earnings, to Price	19.64%
CB	Cash Earnings to Book Value	17.14%
D-12P	12-month growth in Dividends, to Price	15.51%
D-24P	24-month growth in Dividends, to Price	14.64%
PO	Payout Ratio	14.03%
ROE	Return on Equity	13.95%

Appendix C.6.3: In-Sample Cumulative Monthly Payoffs to Momentum Style Attributes

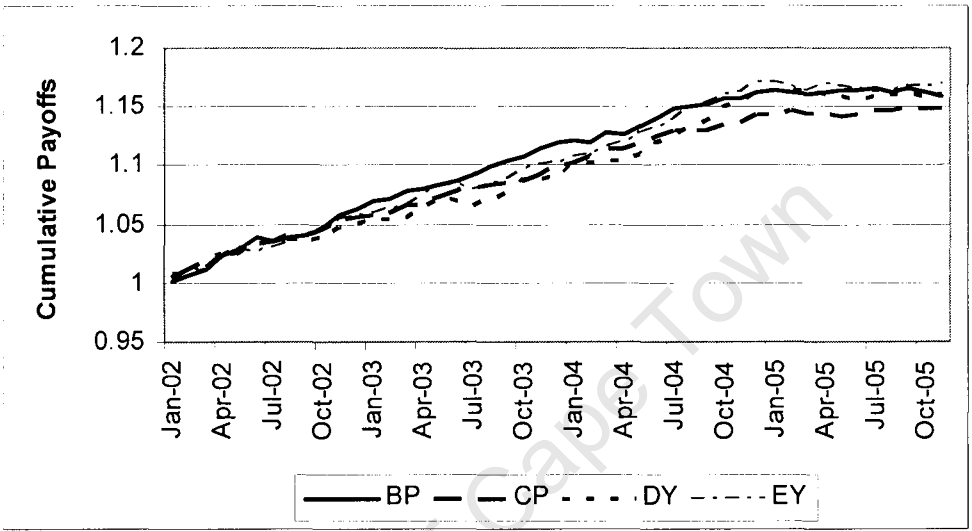
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'momentum' style group. The table shows the cumulative payoffs as at the end of the in-sample period: 31 December 2001. The attributes are 1, 3, 6 and 12-month prior return (MOM-1, MOM-3, MOM-6 & MOM-12), all of which are significant at the 5% level over the in-sample period, from 31 January 1995 to 31 December 2001, in the cross-sectional OLS regression tests on the unadjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MOM-12	12-month prior return	64.66%
MOM-6	6-month prior return	60.57%
MOM-3	3-month prior return	35.91%
MOM-1	1-month prior return	26.08%

Appendix C.7.1: Out-Sample Cumulative Monthly Payoffs to Value Style Attributes using Single-Index Model Adjusted Returns

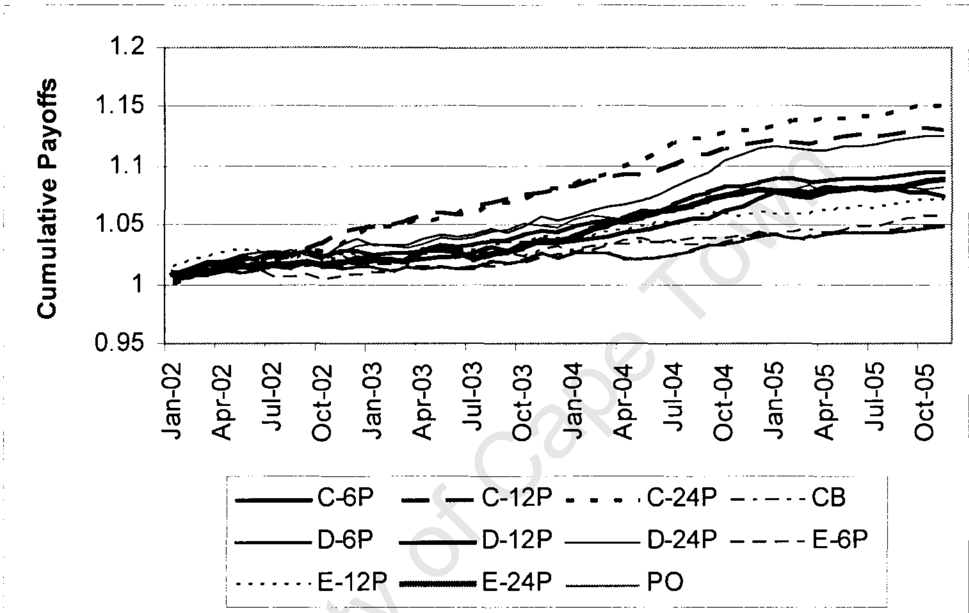
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'value' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are book value per share to price (BP), cash earnings per share to price (CP), dividend yield (DY) and earnings yield (EY), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Single-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
EY	Earnings Yield	16.88%
DY	Dividend Yield	16.08%
BP	Book Value per Share to Price	15.92%
CP	Cash Earnings per Share to Price	14.85%

Appendix C.7.2: Out-Sample Cumulative Monthly Payoffs to Growth Style Attributes using Single-Index Model Adjusted Returns

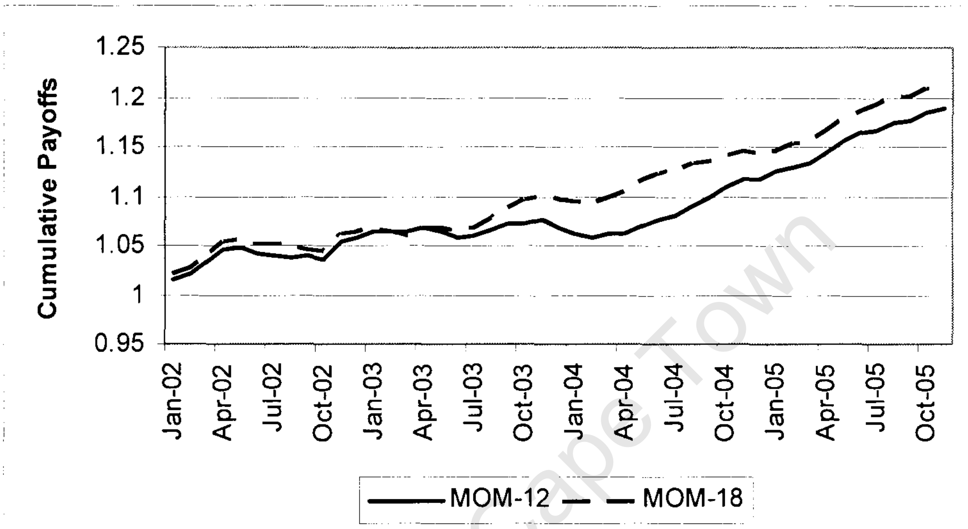
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'growth' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are 6, 12 and 24-month growth in cash earnings, to price (C-6P, C-12P & C-24P), cash earnings to book value (CB), 6, 12 and 24-month growth in dividends, to price (D-6P, D-12P & D-24P), 6, 12 and 24-month growth in earnings, to price (E-6P, E-12P & E-24P) and the payout ratio (PO), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Single-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
C-24P	24-month growth in Cash Earnings, to Price	15.06%
C-12P	12-month growth in Cash Earnings, to Price	12.94%
D-24P	24-month growth in Dividends, to Price	12.53%
D-12P	12-month growth in Dividends, to Price	9.40%
E-24P	24-month growth in Earnings, to Price	8.70%
PO	Payout Ratio	8.04%
C-6P	6-month growth in Cash Earnings, to Price	7.46%
E-12P	12-month growth in Earnings, to Price	7.15%
E-6P	6-month growth in Earnings, to Price	5.78%
CB	Cash Earnings to Book Value	4.88%
D-6P	6-month growth in Dividends, to Price	4.81%

Appendix C.7.3: Out-Sample Cumulative Monthly Payoffs to Momentum Style Attributes using Single-Index Model Adjusted Returns

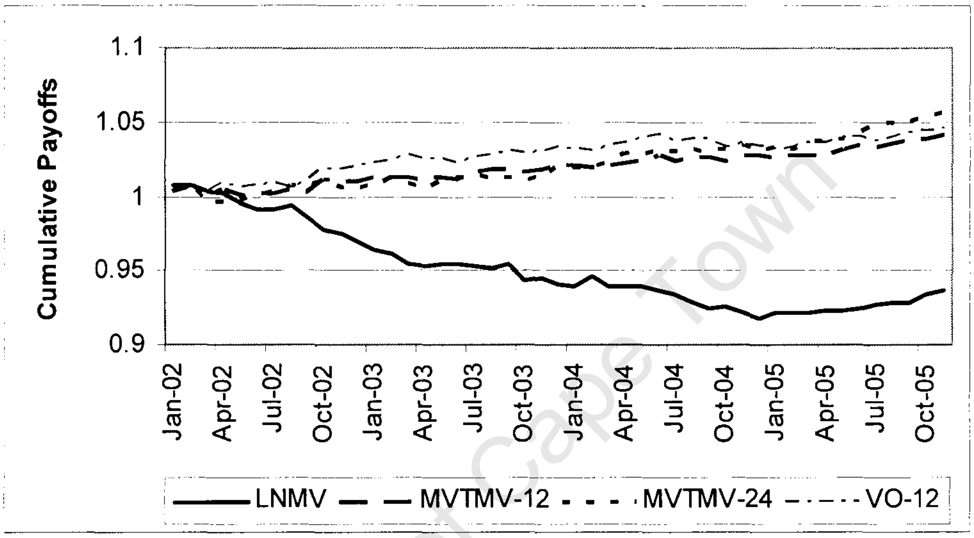
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'momentum' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are 12 and 18-month prior return (MOM-12 & MOM-18), both of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Single-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MOM-18	18-month prior return	21.45%
MOM-12	12-month prior return	18.94%

Appendix C.7.4: Out-Sample Cumulative Monthly Payoffs to Size and Liquidity Style Attributes using Single-Index Model Adjusted Returns

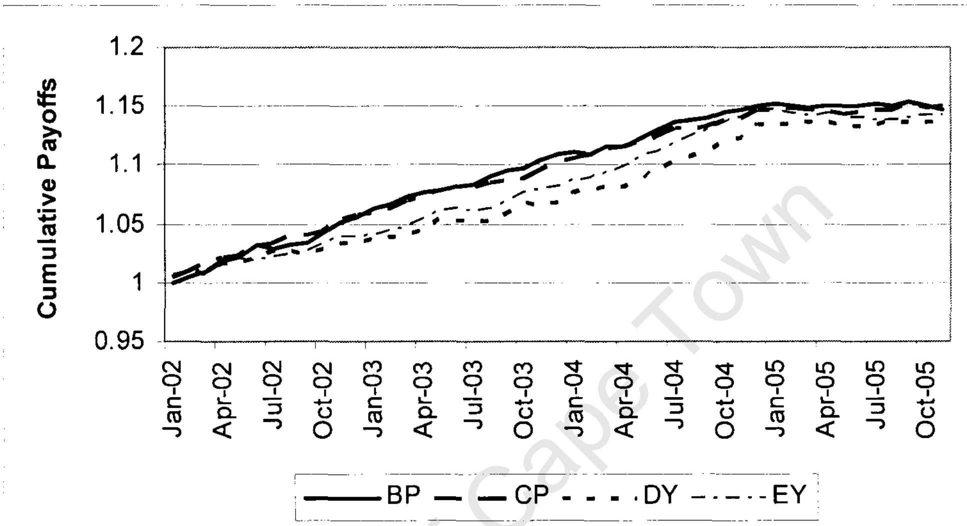
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'size and liquidity' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are the natural log of market value (LNMV), 12 and 24-month growth in market value traded to market value (MVTMV-12 & MVTMV-24) and 12-month growth in turnover by volume (VO-12), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Single-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MVTMV-24	24-month growth in Market Value Traded to Market Value	5.60%
VO-12	12-month growth in Turnover by Volume	4.57%
MVTMV-12	12-month growth in Market Value Traded to Market Value	4.14%
LNMV	Natural Log of Market Value	-6.29%

Appendix C.8.1: Out-Sample Cumulative Monthly Payoffs to Value Style Attributes using Empirical ICAPM Adjusted Returns

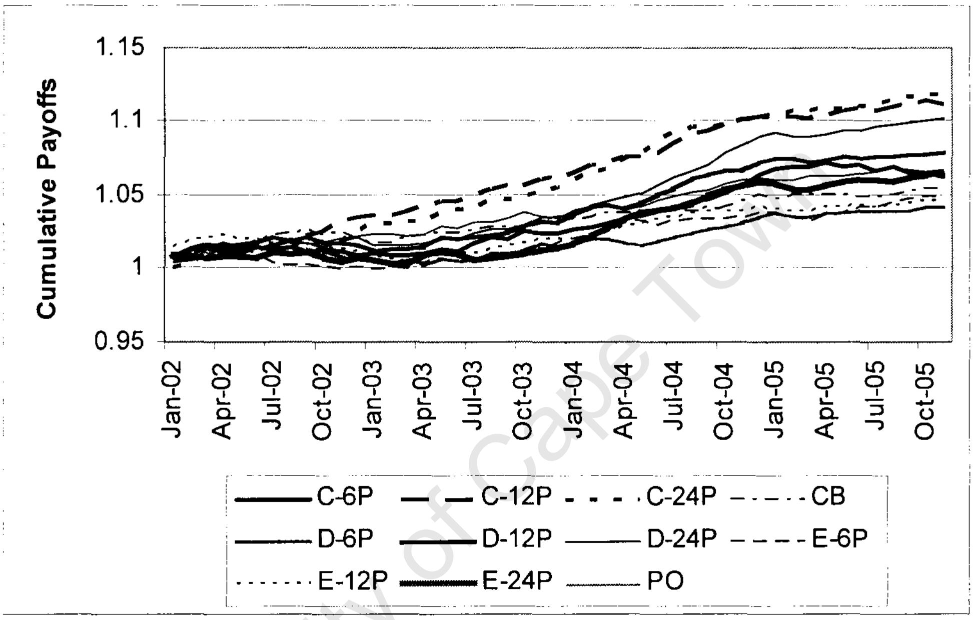
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'value' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are book value per share to price (BP), cash earnings per share to price (CP), dividend yield (DY) and earnings yield (EY), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the empirical ICAPM adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
CP	Cash Earnings per Share to Price	15.01%
BP	Book Value per Share to Price	14.75%
EY	Earnings Yield	14.26%
DY	Dividend Yield	13.85%

Appendix C.8.2: Out-Sample Cumulative Monthly Payoffs to Growth Style Attributes using Empirical ICAPM Adjusted Returns

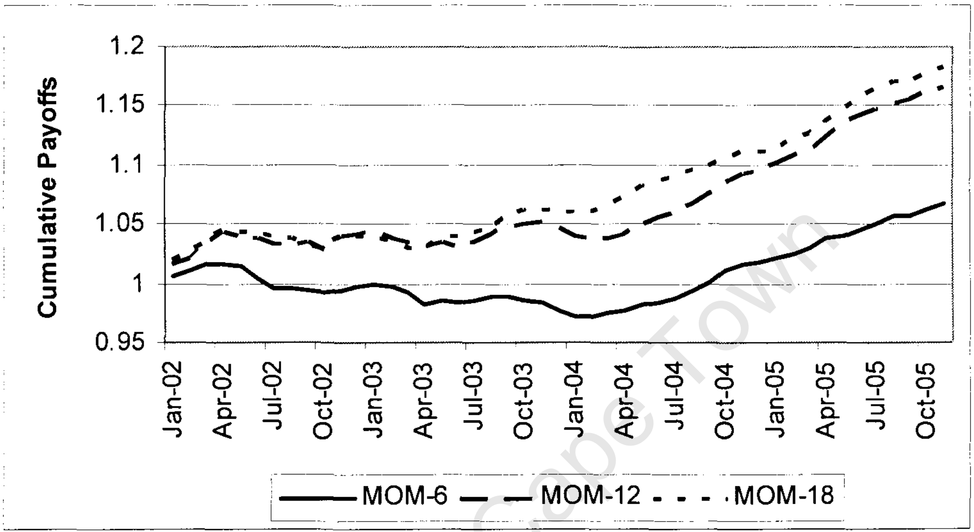
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'growth' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are 6, 12 and 24-month growth in cash earnings, to price (C-6P, C-12P & C-24P), cash earnings to book value (CB), 6, 12 and 24-month growth in dividends, to price (D-6P, D-12P & D-24P), 6, 12 and 24-month growth in earnings, to price (E-6P, E-12P & E-24P) and the payout ratio (PO), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the empirical ICAPM adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
C-24P	24-month growth in Cash Earnings, to Price	11.90%
C-12P	12-month growth in Cash Earnings, to Price	11.14%
D-24P	24-month growth in Dividends, to Price	10.20%
D-12P	12-month growth in Dividends, to Price	7.82%
PO	Payout Ratio	6.67%
E-24P	24-month growth in Earnings, to Price	6.45%
C-6P	6-month growth in Cash Earnings, to Price	6.17%
CB	Cash Earnings to Book Value	5.42%
E-6P	6-month growth in Earnings, to Price	4.91%
E-12P	12-month growth in Earnings, to Price	4.66%
D-6P	6-month growth in Dividends, to Price	4.24%

Appendix C.8.3: Out-Sample Cumulative Monthly Payoffs to Momentum Style Attributes using Empirical ICAPM Adjusted Returns

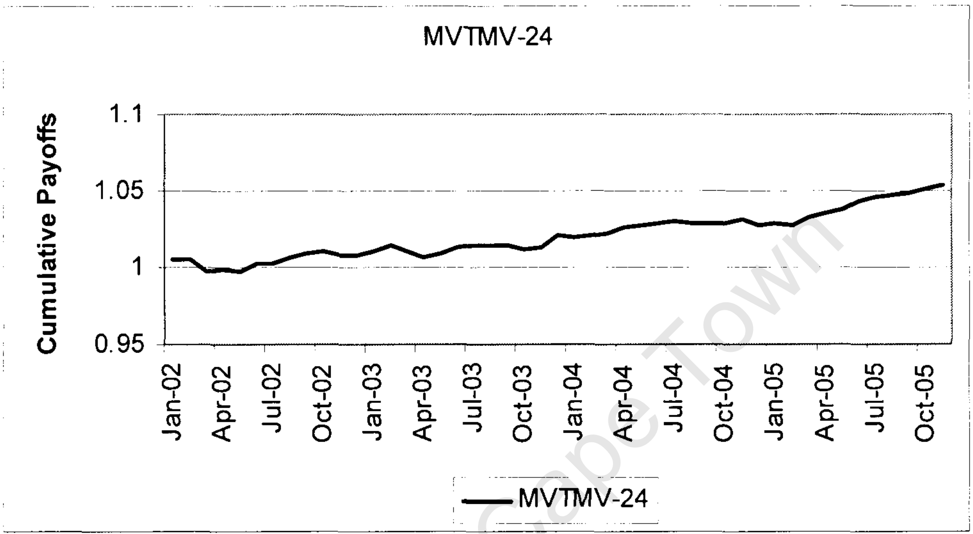
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'momentum' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are 6, 12 and 18-month prior return (MOM-6, MOM-12 & MOM-18), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the empirical ICAPM adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MOM-18	18-month prior return	18.22%
MOM-12	12-month prior return	16.65%
MOM-6	6-month prior return	6.72%

Appendix C.8.4: Out-Sample Cumulative Monthly Payoffs to Size and Liquidity Style Attributes using Empirical ICAPM Adjusted Returns

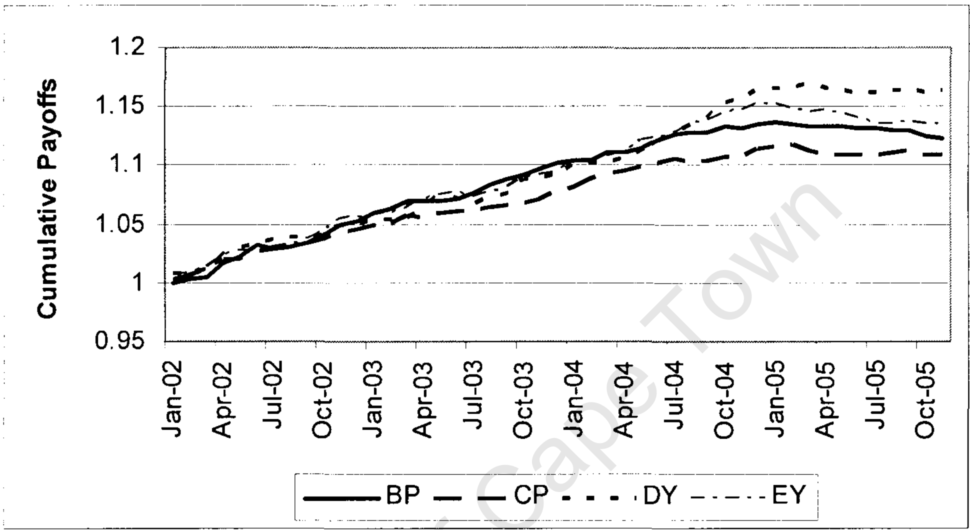
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'size and liquidity' style group. The table shows the cumulative payoff as at the end of the out-sample period: 31 December 2005. Only 24-month growth in market value traded to market value (MVTMV-24) is significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the empirical ICAPM adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MVTMV-24	24-month growth in Market Value Traded to Market Value	5.44%

Appendix C.9.1: Out-Sample Cumulative Monthly Payoffs to Value Style Attributes using Multi-Index Model Adjusted Returns

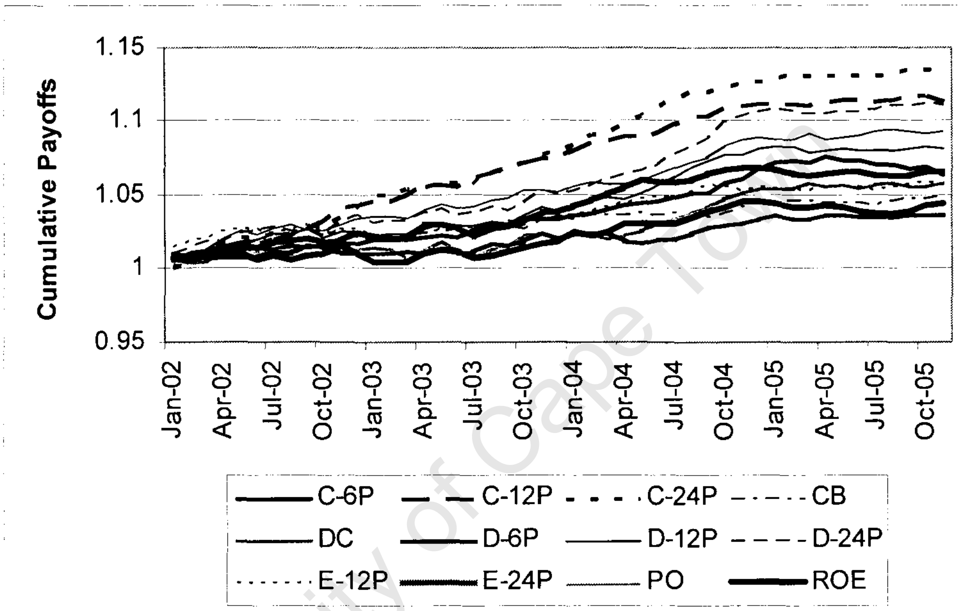
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'value' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are book value per share to price (BP), cash earnings per share to price (CP), dividend yield (DY) and earnings yield (EY), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Multi-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
DY	Dividend Yield	16.33%
EY	Earnings Yield	13.56%
BP	Book Value per Share to Price	12.27%
CP	Cash Earnings per Share to Price	10.88%

Appendix C.9.2: Out-Sample Cumulative Monthly Payoffs to Growth Style Attributes using Multi-Index Model Adjusted Returns

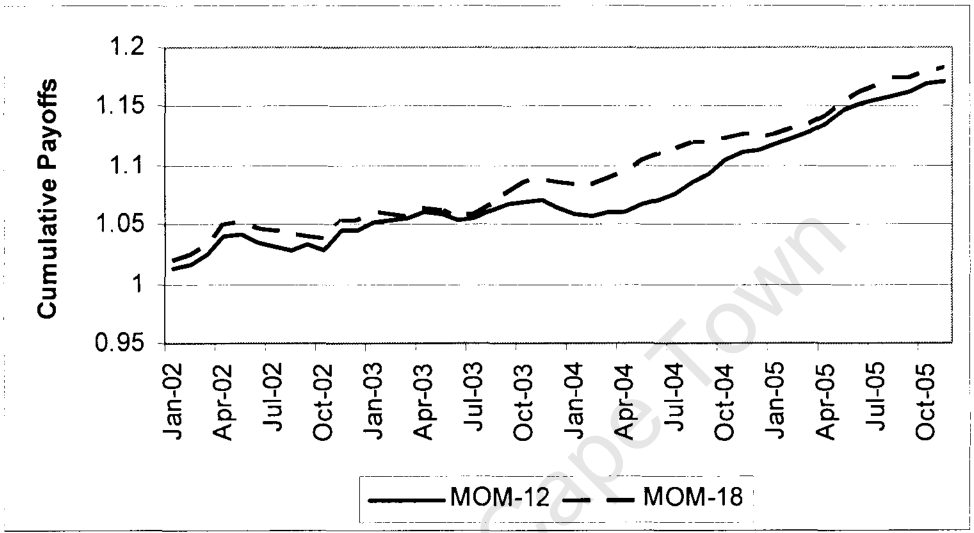
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'growth' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are 6, 12 and 24-month growth in cash earnings, to price (C-6P, C-12P & C-24P), cash earnings to book value (CB), dividends to cash earnings (DC), 6, 12 and 24-month growth in dividends, to price (D-6P, D-12P & D-24P), 12 and 24-month growth in earnings, to price (E-12P & E-24P), the payout ratio (PO) and return on equity (ROE), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Multi-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
C-24P	24-month growth in Cash Earnings, to Price	13.31%
C-12P	12-month growth in Cash Earnings, to Price	11.29%
D-24P	24-month growth in Dividends, to Price	11.08%
PO	Payout Ratio	9.25%
D-12P	12-month growth in Dividends, to Price	8.18%
E-24P	24-month growth in Earnings, to Price	6.46%
C-6P	6-month growth in Cash Earnings, to Price	6.40%
DC	Dividends to Cash Earnings	5.83%
E-12P	12-month growth in Earnings, to Price	5.75%
CB	Cash Earnings to Book Value	4.85%
ROE	Return on Equity	4.50%
D-6P	6-month growth in Dividends, to Price	3.57%

Appendix C.9.3: Out-Sample Cumulative Monthly Payoffs to Momentum Style Attributes using Multi-Index Model Adjusted Returns

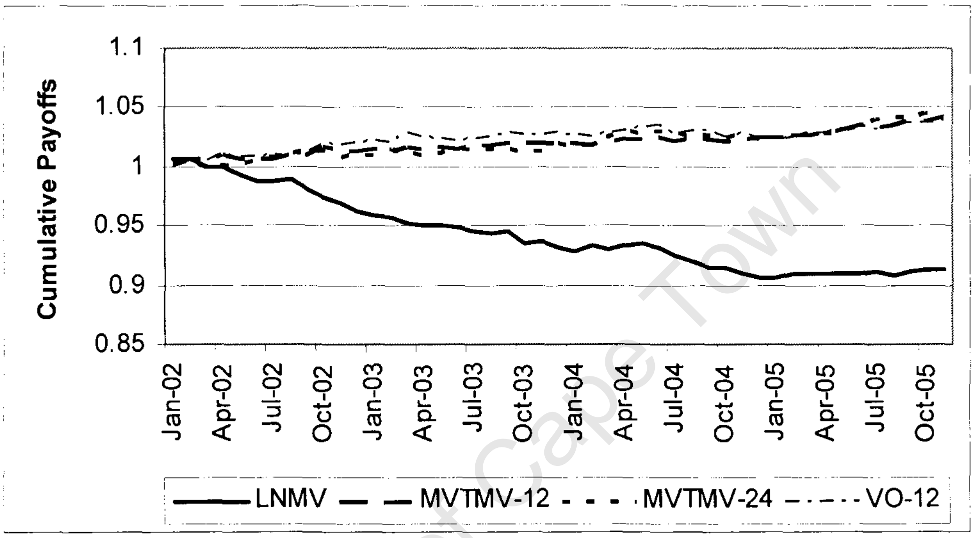
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'momentum' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are 12 and 18-month prior return (MOM-12 & MOM-18), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Multi-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MOM-18	18-month prior return	18.24%
MOM-12	12-month prior return	17.09%

Appendix C.9.4: Out-Sample Cumulative Monthly Payoffs to Size and Liquidity Style Attributes using Multi-Index Model Adjusted Returns

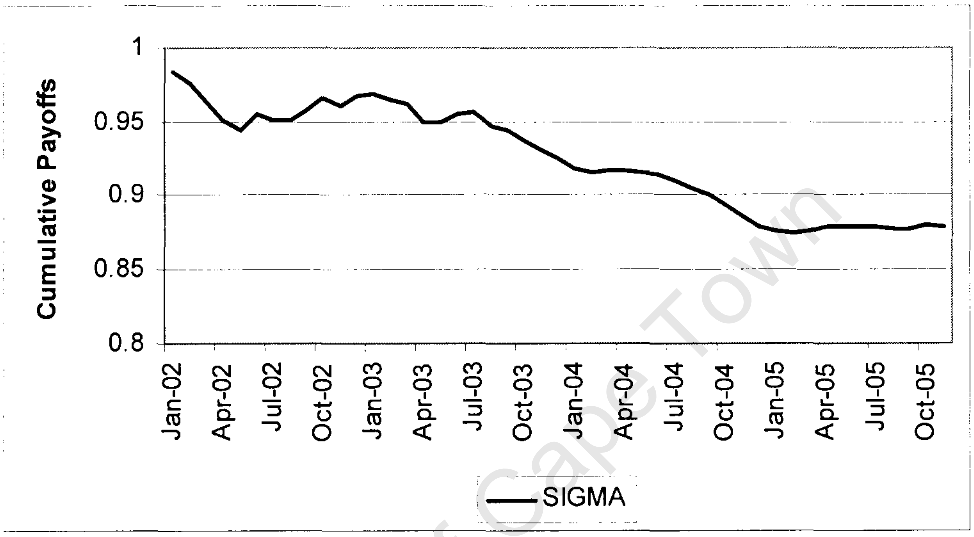
The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'size and liquidity' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The attributes are the natural log of market value (LNMV), 12 and 24-month growth in market value traded to market value (MVTMV-12 & MVTMV-24) and 12-month growth in turnover by volume (VO-12), all of which are significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Multi-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
MVTMV-24	24-month growth in Market Value Traded to Market Value	4.82%
MVTMV-12	12-month growth in Market Value Traded to Market Value	4.21%
VO-12	12-month growth in Turnover by Volume	3.96%
LNMV	Natural Log of Market Value	-8.65%

Appendix C.9.5: Out-Sample Cumulative Monthly Payoffs to Risk Style Attributes using Multi-Index Model Adjusted Returns

The figure displays the cumulative monthly payoffs to the significant sector-specific attributes which fall in the 'risk' style group. The table shows the cumulative payoffs as at the end of the out-sample period: 31 December 2005. The only attribute under consideration in the 'risk' style group is the volatility in 12-month prior returns (SIGMA), which is significant at the 5% level over the out-sample period, from 31 January 2002 to 31 December 2005, in the cross-sectional OLS regression tests on the Multi-Index model adjusted returns data. Table 4.1 displays the attribute codes, characteristics and formulae for construction. All data was obtained from Datastream International at the University of Cape Town.



Code	Characteristic	Cumulative Payoff
SIGMA	Volatility in 12-month prior returns	-12.13%

Appendix C.10: Correlation Matrix for Significant In-Sample Attributes using Unadjusted Returns

The table shows the Pearson correlations between the time series of monthly payoffs to those sector-specific attributes which are significant in the in-sample period from 31 January 1995 to 31 December 2001. The attributes exhibit at least a 5% level of significance in the OLS cross-sectional regression tests on the unadjusted returns data. Attribute pairs with a high degree of correlation i.e. greater than 0.7 or less than -0.7 are presented in white against a black background. All data was obtained from Datastream International at the University of Cape Town.

	CP	DY	C-6P	C-12P	CB	D-12P	D-24P	PO	ROE	MOM-1	MOM-3	MOM-6	MOM-12
CP	1.000												
DY	0.359	1.000											
C-6P	-0.121	-0.339	1.000										
C-12P	-0.105	-0.335	0.686	1.000									
CB	-0.058	-0.186	0.222	0.308	1.000								
D-12P	-0.377	-0.104	0.416	0.607	0.291	1.000							
D-24P	-0.387	-0.016	0.179	0.399	0.359	0.729	1.000						
PO	-0.014	0.515	-0.086	-0.186	0.091	0.027	0.025	1.000					
ROE	-0.378	0.091	0.154	0.223	0.473	0.450	0.549	-0.120	1.000				
MOM-1	-0.313	-0.278	0.341	0.272	0.051	0.126	0.104	-0.034	0.061	1.000			
MOM-3	-0.275	-0.291	0.507	0.401	0.264	0.252	0.169	0.009	0.200	0.632	1.000		
MOM-6	-0.213	-0.335	0.613	0.527	0.325	0.329	0.195	-0.016	0.228	0.572	0.834	1.000	
MOM-12	-0.373	-0.428	0.557	0.586	0.437	0.522	0.383	-0.104	0.393	0.470	0.698	0.820	1.000

Appendix C.11: Correlation Matrix for Significant Out-Sample Attributes using Unadjusted Returns

The table shows the Pearson correlations between the time series of monthly payoffs to those sector-specific attributes which are significant in the out-sample period from 31 January 2002 to 31 December 2005. The attributes exhibit at least a 5% level of significance in the OLS cross-sectional regression tests on the unadjusted returns data. Attribute pairs with a high degree of correlation i.e. greater than 0.7 or less than -0.7 are presented in white against a black background. All data was obtained from Datastream International at the University of Cape Town.

	BP	CP	DY	EY	C-6P	C-12P	C-24P	CB	D-12P	D-24P	E-6P	E-12P	E-24P	PO	MOM-12	MOM-18
BP	1.000															
CP	0.594	1.000														
DY	0.275	0.143	1.000													
EY	0.492	0.530	0.649	1.000												
C-6P	0.260	0.016	0.304	0.353	1.000											
C-12P	0.264	0.338	0.233	0.508	0.248	1.000										
C-24P	0.259	0.036	0.058	0.333	0.307	0.558	1.000									
CB	-0.037	0.567	0.175	0.408	-0.084	0.274	-0.136	1.000								
D-12P	0.166	-0.028	0.381	0.351	0.350	0.212	0.553	0.051	1.000							
D-24P	0.068	-0.179	0.475	0.323	0.371	0.200	0.440	-0.117	0.779	1.000						
E-6P	0.051	0.036	0.132	0.357	0.290	0.418	0.484	0.096	0.410	0.437	1.000					
E-12P	0.095	-0.023	0.161	0.325	0.338	0.336	0.566	0.069	0.646	0.597	0.670	1.000				
E-24P	0.070	-0.171	0.208	0.411	0.260	0.395	0.698	-0.054	0.693	0.676	0.536	0.727	1.000			
PO	-0.116	-0.263	0.727	0.121	0.192	-0.035	-0.098	-0.093	0.309	0.492	0.073	0.131	0.121	1.000		
MOM-12	0.052	-0.264	0.126	0.166	0.288	0.316	0.563	-0.093	0.612	0.594	0.454	0.703	0.713	0.221	1.000	
MOM-18	0.071	-0.240	0.238	0.256	0.442	0.332	0.703	-0.127	0.744	0.684	0.519	0.751	0.805	0.278	0.886	1.000

Appendix C.12: Correlation Matrix for Significant Out-Sample Attributes using Single-Index Model Adjusted Returns

The table shows the Pearson correlations between the time series of monthly payoffs to those sector-specific attributes which are significant in the out-sample period from 31 January 2002 to 31 December 2005. The attributes exhibit at least a 5% level of significance in the OLS cross-sectional regression tests on the Single-Index model adjusted returns data. Attribute pairs with a high degree of correlation i.e. greater than 0.7 or less than -0.7 are presented in white against a black background. All data was obtained from Datastream International at the University of Cape Town.

	BP	CP	DY	EY	C-6P	C-12P	C-24P	CB	D-6P	D-12P	D-24P	E-6P	E-12P	E-24P	PO	MOM-12	MOM-18	LNMV	MVTMV-12	MVTMV-24	VO-12
BP	1.000																				
CP	0.713	1.000																			
DY	0.315	0.308	1.000																		
EY	0.437	0.371	0.712	1.000																	
C-6P	0.186	0.203	0.428	0.369	1.000																
C-12P	0.384	0.276	0.358	0.519	0.393	1.000															
C-24P	0.315	0.227	0.255	0.263	0.165	0.322	1.000														
CB	0.056	0.427	-0.002	-0.007	0.122	0.109	0.116	1.000													
D-6P	-0.091	-0.111	0.171	0.094	0.300	0.150	0.143	0.159	1.000												
D-12P	0.091	0.220	0.531	0.431	0.413	0.384	0.271	0.252	0.581	1.000											
D-24P	0.106	0.160	0.510	0.381	0.426	0.450	0.292	0.273	0.432	0.807	1.000										
E-6P	0.016	0.060	-0.023	0.290	0.195	0.285	0.137	0.135	0.149	0.152	0.205	1.000									
E-12P	-0.058	0.062	0.179	0.320	0.294	0.213	0.118	0.276	0.339	0.562	0.481	0.478	1.000								
E-24P	-0.153	-0.161	0.401	0.480	0.177	0.215	0.253	0.049	0.311	0.452	0.552	0.333	0.603	1.000							
PO	0.143	0.133	0.754	0.349	0.362	0.290	0.210	-0.046	0.166	0.417	0.447	-0.097	0.154	0.278	1.000						
MOM-12	0.077	-0.104	0.183	0.218	0.251	0.365	0.254	0.058	0.191	0.339	0.457	0.407	0.484	0.326	0.241	1.000					
MOM-18	0.103	0.018	0.272	0.275	0.299	0.283	0.246	0.067	0.079	0.315	0.388	0.427	0.589	0.388	0.344	0.850	1.000				
LNMV	-0.463	-0.144	-0.158	-0.317	-0.052	-0.198	-0.178	0.161	0.071	0.087	0.042	0.144	0.328	0.130	0.080	0.157	0.280	1.000			
MVTMV-12	0.003	0.045	-0.223	-0.135	0.028	-0.077	-0.308	-0.049	0.022	-0.278	-0.360	-0.031	-0.093	-0.260	-0.063	-0.160	-0.034	0.017	1.000		
MVTMV-24	-0.196	-0.127	-0.274	-0.317	-0.167	-0.409	-0.435	-0.018	-0.170	-0.331	-0.293	-0.129	-0.116	-0.160	-0.169	-0.349	-0.223	0.263	0.444	1.000	
VO-12	0.142	0.028	-0.276	-0.039	-0.205	0.059	0.021	0.005	-0.060	-0.365	-0.440	0.095	-0.125	-0.199	-0.237	0.012	0.065	-0.195	0.687	0.196	1.000

Appendix C.13: Correlation Matrix for Significant Out-Sample Attributes using Empirical ICAPM Adjusted Returns

The table shows the Pearson correlations between the time series of monthly payoffs to those sector-specific attributes which are significant in the out-sample period from 31 January 2002 to 31 December 2005. The attributes exhibit at least a 5% level of significance in the OLS cross-sectional regression tests on the empirical ICAPM adjusted returns data. Attribute pairs with a high degree of correlation i.e. greater than 0.7 or less than -0.7 are presented in white against a black background. All data was obtained from Datastream International at the University of Cape Town.

	BP	CP	DY	EY	C-6P	C-12P	C-24P	CB	D-6P	D-12P	D-24P	E-6P	E-12P	E-24P	PO	MOM-6	MOM-12	MOM-18	MVTMV-24
BP	1.000																		
CP	0.736	1.000																	
DY	0.188	0.300	1.000																
EY	0.373	0.393	0.692	1.000															
C-6P	0.061	0.109	0.438	0.353	1.000														
C-12P	0.277	0.265	0.239	0.419	0.387	1.000													
C-24P	0.120	0.172	0.061	0.097	0.088	0.255	1.000												
CB	0.092	0.438	0.047	0.104	0.125	0.096	0.048	1.000											
D-6P	-0.197	-0.050	0.152	0.081	0.349	0.286	0.203	0.249	1.000										
D-12P	-0.036	0.211	0.489	0.393	0.397	0.330	0.178	0.352	0.661	1.000									
D-24P	-0.033	0.177	0.334	0.304	0.424	0.415	0.129	0.343	0.544	0.760	1.000								
E-6P	-0.052	0.048	0.041	0.328	0.285	0.276	0.140	0.151	0.255	0.233	0.319	1.000							
E-12P	-0.137	0.011	0.130	0.295	0.379	0.236	0.065	0.275	0.466	0.582	0.542	0.506	1.000						
E-24P	-0.243	-0.107	0.238	0.462	0.199	0.194	0.146	0.093	0.317	0.423	0.490	0.376	0.615	1.000					
PO	-0.018	0.060	0.697	0.320	0.335	0.177	0.008	-0.093	0.100	0.341	0.248	0.002	0.127	0.097	1.000				
MOM-6	-0.270	-0.355	-0.022	-0.117	0.209	0.043	0.143	-0.088	0.241	0.095	0.310	0.295	0.246	0.086	0.159	1.000			
MOM-12	-0.072	-0.135	0.066	0.003	0.236	0.182	0.105	0.143	0.254	0.250	0.409	0.318	0.483	0.165	0.165	0.804	1.000		
MOM-18	-0.122	-0.100	0.218	0.105	0.288	0.120	0.042	0.098	0.108	0.267	0.360	0.398	0.579	0.281	0.325	0.611	0.847	1.000	
MVTMV-24	-0.191	-0.200	-0.207	-0.307	-0.076	-0.162	-0.087	-0.070	-0.008	-0.163	-0.184	-0.030	0.033	-0.023	-0.050	0.032	-0.116	0.044	1.000

Appendix C.14: Correlation Matrix for Significant Out-Sample Attributes using Multi-Index Model Adjusted Returns

The table shows the Pearson correlations between the time series of monthly payoffs to those sector-specific attributes which are significant in the out-sample period from 31 January 2002 to 31 December 2005. The attributes exhibit at least a 5% level of significance in the OLS cross-sectional regression tests on the Multi-Index model adjusted returns data. Attribute pairs with a high degree of correlation i.e. greater than 0.7 or less than -0.7 are presented in white against a black background. All data was obtained from Datastream International at the University of Cape Town.

	BP	CP	DY	EY	C-6P	C-12P	C-24P	CB	DC	D-6P	D-12P	D-24P	E-12P	E-24P	PO	ROE	MOM-12	MOM-18	LNMV	MVTMV-12	MVTMV-24	VO-12	SIGMA
BP	1.000																						
CP	0.710	1.000																					
DY	0.327	0.326	1.000																				
EY	0.485	0.462	0.702	1.000																			
C-6P	0.253	0.301	0.499	0.422	1.000																		
C-12P	0.443	0.333	0.367	0.578	0.401	1.000																	
C-24P	0.411	0.363	0.323	0.377	0.214	0.420	1.000																
CB	0.011	0.364	0.071	0.063	0.144	0.162	0.135	1.000															
DC	-0.043	-0.134	0.760	0.358	0.448	0.095	0.147	-0.104	1.000														
D-6P	-0.019	-0.068	0.205	0.095	0.280	0.072	0.154	0.198	0.197	1.000													
D-12P	0.096	0.170	0.578	0.451	0.375	0.328	0.330	0.288	0.390	0.532	1.000												
D-24P	0.068	0.104	0.546	0.409	0.405	0.373	0.326	0.376	0.452	0.366	0.785	1.000											
E-12P	-0.041	0.011	0.242	0.367	0.264	0.219	0.149	0.270	0.241	0.276	0.580	0.547	1.000										
E-24P	-0.078	-0.064	0.425	0.509	0.190	0.246	0.303	0.102	0.434	0.253	0.464	0.574	0.633	1.000									
PO	0.147	0.107	0.759	0.363	0.418	0.261	0.233	0.041	0.772	0.168	0.460	0.495	0.251	0.355	1.000								
ROE	-0.169	-0.090	0.437	0.569	0.136	0.315	0.037	0.233	0.357	0.152	0.360	0.471	0.442	0.510	0.169	1.000							
MOM-12	0.089	-0.135	0.248	0.248	0.229	0.340	0.258	0.051	0.301	0.098	0.329	0.432	0.457	0.276	0.365	0.322	1.000						
MOM-18	0.132	0.004	0.308	0.313	0.238	0.290	0.269	0.044	0.367	-0.010	0.300	0.355	0.547	0.373	0.414	0.330	0.828	1.000					
LNMV	-0.409	-0.144	-0.194	-0.289	-0.115	-0.250	-0.170	0.179	0.005	-0.082	-0.034	-0.061	0.295	0.173	0.014	0.026	0.130	0.273	1.000				
MVTMV-12	-0.003	0.044	-0.271	-0.095	-0.011	-0.115	-0.299	-0.046	-0.139	0.020	-0.328	-0.394	-0.072	-0.239	-0.165	-0.095	-0.034	0.086	0.049	1.000			
MVTMV-24	-0.196	-0.124	-0.369	-0.370	-0.227	-0.470	-0.457	-0.108	-0.220	-0.159	-0.350	-0.305	-0.028	-0.114	-0.239	-0.189	-0.339	-0.172	0.331	0.231	1.000		
VO-12	0.166	0.043	-0.286	0.012	-0.243	0.050	0.048	-0.074	-0.310	-0.052	-0.357	-0.399	-0.124	-0.123	-0.271	-0.076	0.106	0.167	-0.079	0.722	0.113	1.000	
SIGMA	-0.037	-0.173	-0.596	-0.455	-0.426	-0.306	-0.290	-0.417	-0.490	-0.243	-0.535	-0.583	-0.520	-0.518	-0.611	-0.552	-0.483	-0.532	-0.111	0.177	0.350	0.213	1.000

Appendix D

Appendix D contains material associated with chapter 7: Style Timing.

Appendix D.1: Ljung-Box Q-Statistics of Monthly Payoffs to Significant Attributes

The table shows the Ljung-Box Q-statistics for significant attribute payoffs for lags one to twelve. Q-statistics which are significant at the 5% level are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Lags											
		1	2	3	4	5	6	7	8	9	10	11	12
Value	BP	**20.654**	**25.141**	**27.433**	**29.287**	**36.305**	**45.825**	**57.274**	**58.407**	**58.429**	**60.110**	**60.166**	**60.394**
	CP	2.311	2.319	3.789	3.795	4.554	9.031	9.035	9.742	10.005	10.929	11.218	12.349
	DY	**16.698**	**19.334**	**19.459**	**19.744**	**24.316**	**27.794**	**35.056**	**35.149**	**35.355**	**36.879**	**36.896**	**37.137**
	EY	3.549	4.821	**8.027**	9.002	**15.979**	**25.566**	**33.996**	**35.022**	**35.028**	**35.806**	**36.860**	**42.062**
Growth	C-6P	**8.792**	**14.162**	**15.978**	**15.991**	**16.199**	**17.552**	**17.562**	**20.863**	**20.878**	**20.908**	**21.195**	**24.444**
	C-12P	2.969	4.163	4.440	4.518	4.672	9.782	9.809	**16.737**	**17.196**	17.257	17.494	17.495
	C-24P	**4.287**	**7.024**	7.524	9.047	10.177	10.576	11.186	11.305	11.382	12.530	18.798	20.846
	CB	**6.463**	**21.178**	**21.395**	**21.795**	**21.804**	**25.622**	**27.327**	**28.567**	**28.604**	**29.809**	**34.630**	**41.411**
	D-12P	**13.785**	**13.791**	**14.753**	**16.947**	**16.972**	**18.063**	**18.176**	**18.568**	**19.043**	**25.925**	**31.083**	**31.472**
	D-24P	**17.649**	**21.462**	**21.467**	**22.146**	**22.182**	**25.207**	**25.886**	**27.127**	**27.164**	**33.272**	**41.856**	**47.216**
	E-6P	**4.408**	**5.972**	6.313	7.587	10.520	**15.357**	**16.628**	**18.277**	**18.305**	**18.332**	18.482	18.907
	E-12P	**10.872**	**10.944**	**10.997**	**11.078**	**11.174**	11.503	11.770	12.241	12.400	12.696	18.492	19.110
	E-24P	**4.611**	**7.019**	7.608	7.846	8.663	12.194	13.093	13.181	13.287	14.536	18.046	18.178
	PO	3.722	3.901	5.425	5.470	5.580	5.807	5.866	5.868	5.954	13.290	15.261	16.889
	ROE	**4.077**	4.467	6.978	7.133	8.230	10.484	10.728	11.017	11.137	13.758	15.914	16.645
Momentum	MOM-1	0.288	0.589	0.761	8.086	8.278	8.307	9.331	10.836	10.861	11.724	11.774	12.208
	MOM-3	0.049	0.810	0.811	7.351	7.981	7.983	8.060	9.594	10.213	12.059	12.580	13.016
	MOM-6	3.720	3.902	4.815	7.901	8.333	8.409	9.091	12.790	12.935	14.817	14.926	15.516
	MOM-12	**12.291**	**12.331**	**13.428**	**15.235**	**16.200**	**17.710**	**19.168**	**19.346**	**19.652**	**19.827**	**19.975**	20.602
	MOM-18	**19.873**	**21.164**	**21.203**	**21.236**	**23.525**	**25.364**	**27.058**	**27.082**	**27.305**	**27.634**	**27.653**	**28.622**

Appendix D.2: Forecasting Statistics for Significant Attributes using an Historic Mean Model

The table shows six forecasting statistics for the forecasts made by the historic mean (HIST) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.119	0.577	0.033	0.849	0.048	0.649	0.303
	CP	0.059	0.669	0.000	0.771	0.041	0.670	0.288
	DY	0.020	0.646	0.000	0.631	0.000	0.610	0.390
	EY	0.010	0.662	0.000	0.774	0.009	0.731	0.260
Growth	C-6P	-0.073	0.654	0.000	0.675	0.008	0.675	0.317
	C-12P	-0.190	0.738	0.000	0.634	0.000	0.768	0.232
	C-24P	-0.171	0.662	0.000	0.737	0.003	0.798	0.200
	CB	-0.024	0.638	0.001	0.705	0.006	0.715	0.279
	D-12P	0.042	0.685	0.000	0.670	0.019	0.671	0.310
	D-24P	-0.057	0.669	0.000	0.706	0.004	0.717	0.279
	E-6P	-0.050	0.585	0.022	0.819	0.000	0.682	0.318
	E-12P	-0.125	0.569	0.048	0.832	0.001	0.696	0.303
	E-24P	-0.072	0.600	0.009	0.823	0.000	0.690	0.309
	PO	-0.007	0.615	0.003	0.699	0.007	0.625	0.368
	ROE	-0.015	0.608	0.005	0.723	0.015	0.732	0.253
Momentum	MOM-1	0.004	0.585	0.022	0.801	0.000	0.679	0.321
	MOM-3	-0.045	0.577	0.033	0.770	0.001	0.757	0.242
	MOM-6	-0.049	0.669	0.000	0.710	0.001	0.764	0.235
	MOM-12	-0.023	0.700	0.000	0.651	0.004	0.778	0.218
	MOM-18	-0.035	0.646	0.000	0.787	0.001	0.716	0.284

Appendix D.3: Forecasting Statistics for Significant Attributes using an MA-6 Model

The table shows six forecasting statistics for the forecasts made by the 6-month moving average (MA-6) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.372	0.656	0.000	0.579	0.000	0.161	0.832
	CP	0.193	0.632	0.001	0.595	0.000	0.259	0.763
	DY	0.273	0.664	0.000	0.554	0.001	0.185	0.795
	EY	0.312	0.712	0.000	0.585	0.000	0.217	0.752
Growth	C-6P	0.146	0.576	0.037	0.622	0.001	0.186	0.838
	C-12P	0.023	0.736	0.000	0.607	0.000	0.218	0.793
	C-24P	0.051	0.616	0.004	0.652	0.000	0.206	0.786
	CB	0.225	0.632	0.001	0.618	0.000	0.183	0.806
	D-12P	0.074	0.560	0.076	0.670	0.000	0.222	0.755
	D-24P	0.180	0.656	0.000	0.631	0.000	0.178	0.805
	E-6P	0.226	0.536	0.186	0.650	0.000	0.230	0.755
	E-12P	0.134	0.568	0.054	0.688	0.000	0.205	0.773
	E-24P	0.216	0.560	0.076	0.658	0.000	0.204	0.766
	PO	0.059	0.584	0.024	0.681	0.000	0.270	0.739
	ROE	0.207	0.536	0.186	0.646	0.000	0.221	0.772
Momentum	MOM-1	-0.077	0.560	0.076	0.751	0.000	0.294	0.704
	MOM-3	-0.040	0.520	0.296	0.731	0.000	0.290	0.684
	MOM-6	-0.072	0.584	0.024	0.704	0.000	0.263	0.713
	MOM-12	0.105	0.680	0.000	0.625	0.000	0.222	0.749
	MOM-18	0.230	0.664	0.000	0.636	0.000	0.176	0.803

Appendix D.4: Forecasting Statistics for Significant Attributes using an MA-12 Model

The table shows six forecasting statistics for the forecasts made by the 12-month moving average (MA-12) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.260	0.605	0.008	0.635	0.000	0.208	0.752
	CP	0.151	0.605	0.008	0.611	0.000	0.359	0.650
	DY	0.207	0.655	0.000	0.579	0.001	0.271	0.698
	EY	0.283	0.714	0.000	0.603	0.000	0.268	0.682
Growth	C-6P	0.129	0.655	0.000	0.643	0.001	0.368	0.633
	C-12P	-0.088	0.765	0.000	0.626	0.000	0.423	0.564
	C-24P	-0.061	0.672	0.000	0.684	0.001	0.359	0.622
	CB	0.074	0.630	0.002	0.684	0.001	0.359	0.543
	D-12P	-0.052	0.597	0.014	0.720	0.000	0.356	0.600
	D-24P	0.029	0.664	0.000	0.693	0.000	0.278	0.681
	E-6P	0.118	0.597	0.014	0.701	0.000	0.310	0.653
	E-12P	0.006	0.597	0.014	0.757	0.000	0.324	0.620
	E-24P	0.101	0.555	0.100	0.719	0.000	0.285	0.659
	PO	-0.081	0.580	0.033	0.728	0.000	0.419	0.593
	ROE	0.072	0.605	0.008	0.708	0.000	0.308	0.657
Momentum	MOM-1	-0.042	0.487	0.573	0.768	0.000	0.475	0.491
	MOM-3	0.025	0.580	0.033	0.739	0.000	0.435	0.500
	MOM-6	0.079	0.655	0.000	0.684	0.000	0.426	0.508
	MOM-12	0.124	0.672	0.000	0.635	0.000	0.342	0.597
	MOM-18	0.186	0.672	0.000	0.675	0.000	0.273	0.675

Appendix D.5: Forecasting Statistics for Significant Attributes using an MA-18 Model

The table shows six forecasting statistics for the forecasts made by the 18-month moving average (MA-18) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.222	0.664	0.000	0.663	0.000	0.252	0.670
	CP	0.165	0.664	0.000	0.612	0.000	0.405	0.571
	DY	0.192	0.655	0.000	0.591	0.001	0.330	0.613
	EY	0.246	0.717	0.000	0.622	0.000	0.287	0.640
Growth	C-6P	0.145	0.655	0.000	0.651	0.001	0.429	0.535
	C-12P	-0.041	0.726	0.000	0.622	0.000	0.534	0.416
	C-24P	-0.023	0.637	0.001	0.691	0.000	0.498	0.455
	CB	-0.088	0.584	0.030	0.740	0.000	0.350	0.579
	D-12P	-0.011	0.619	0.004	0.731	0.000	0.457	0.472
	D-24P	-0.035	0.628	0.002	0.726	0.000	0.389	0.548
	E-6P	0.054	0.628	0.002	0.737	0.000	0.380	0.555
	E-12P	0.011	0.611	0.007	0.784	0.000	0.431	0.488
	E-24P	0.028	0.628	0.002	0.761	0.001	0.366	0.561
	PO	-0.126	0.584	0.030	0.746	0.001	0.550	0.435
	ROE	0.020	0.593	0.019	0.738	0.000	0.412	0.556
Momentum	MOM-1	-0.068	0.575	0.045	0.787	0.000	0.557	0.371
	MOM-3	-0.015	0.584	0.030	0.755	0.000	0.495	0.410
	MOM-6	0.030	0.690	0.000	0.699	0.000	0.473	0.429
	MOM-12	0.063	0.628	0.002	0.658	0.000	0.392	0.508
	MOM-18	0.115	0.646	0.001	0.713	0.001	0.329	0.595

Appendix D.6: Forecasting Statistics for Significant Attributes using a Single Exponential Smoothing Model

The table shows six forecasting statistics for the forecasts made by the single exponential smoothing (S-EXP) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.270	0.615	0.003	0.635	0.000	0.223	0.777
	CP	0.175	0.662	0.000	0.652	0.004	0.513	0.483
	DY	0.170	0.638	0.001	0.585	0.000	0.296	0.704
	EY	0.261	0.723	0.000	0.623	0.000	0.356	0.644
Growth	C-6P	0.067	0.654	0.000	0.665	0.003	0.560	0.437
	C-12P	-0.231	0.746	0.000	0.627	0.000	0.993	0.007
	C-24P	-0.056	0.662	0.000	0.750	0.007	0.914	0.078
	CB	0.171	0.577	0.033	0.642	0.000	0.259	0.741
	D-12P	-0.076	0.685	0.000	0.698	0.008	0.978	0.014
	D-24P	0.070	0.685	0.000	0.665	0.000	0.219	0.781
	E-6P	0.079	0.562	0.068	0.741	0.000	0.444	0.556
	E-12P	-0.201	0.569	0.048	0.907	0.002	0.989	0.009
	E-24P	0.084	0.608	0.005	0.751	0.000	0.442	0.558
	PO	-0.227	0.615	0.003	0.747	0.000	0.993	0.007
	ROE	-0.082	0.608	0.005	0.761	0.003	0.986	0.011
Momentum	MOM-1	-0.052	0.600	0.009	0.773	0.009	0.923	0.068
	MOM-3	-0.018	0.585	0.022	0.744	0.008	0.915	0.076
	MOM-6	-0.104	0.669	0.000	0.694	0.005	0.986	0.009
	MOM-12	-0.051	0.700	0.000	0.648	0.006	0.872	0.122
	MOM-18	0.110	0.608	0.005	0.696	0.000	0.279	0.721

Appendix D.7: Forecasting Statistics for Significant Attributes using a Double Exponential Smoothing Model

The table shows six forecasting statistics for the forecasts made by the double exponential smoothing (D-EXP) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.265	0.615	0.003	0.629	0.001	0.207	0.792
	CP	0.184	0.692	0.000	0.662	0.006	0.571	0.424
	DY	0.185	0.638	0.001	0.576	0.001	0.237	0.763
	EY	0.274	0.731	0.000	0.598	0.000	0.248	0.752
Growth	C-6P	0.049	0.654	0.000	0.664	0.006	0.641	0.353
	C-12P	-0.095	0.746	0.000	0.664	0.007	0.768	0.224
	C-24P	-0.052	0.638	0.001	0.742	0.008	0.666	0.326
	CB	-0.026	0.638	0.001	0.781	0.007	0.686	0.308
	D-12P	0.011	0.569	0.048	0.746	0.007	0.508	0.485
	D-24P	-0.020	0.631	0.001	0.752	0.007	0.516	0.476
	E-6P	-0.075	0.531	0.215	0.858	0.006	0.691	0.303
	E-12P	-0.076	0.569	0.048	0.839	0.006	0.550	0.445
	E-24P	0.029	0.569	0.048	0.791	0.005	0.478	0.517
	PO	0.038	0.615	0.003	0.779	0.004	0.850	0.147
	ROE	0.037	0.554	0.094	0.777	0.007	0.524	0.469
Momentum	MOM-1	-0.001	0.577	0.033	0.750	0.010	0.625	0.365
	MOM-3	-0.012	0.585	0.022	0.736	0.009	0.726	0.266
	MOM-6	-0.148	0.669	0.000	0.691	0.006	0.967	0.026
	MOM-12	0.103	0.700	0.000	0.682	0.003	0.673	0.324
	MOM-18	0.071	0.623	0.002	0.717	0.001	0.300	0.700

Appendix D.8: Forecasting Statistics for Significant Attributes using a Holt-Winters Exponential Smoothing Model

The table shows six forecasting statistics for the forecasts made by the Holt-Winters exponential smoothing (H-W) model. The forecasts are made over the entire sample period from 31 January 1995 to 31 December 2005. The greater the Pearson (1896) correlation, the direction ratio and the covariance and the closer to zero the Theil (1958) Inequality Coefficient, the bias and the variance, the better the style-timing model performs. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation	Direction Ratio	p-value (Direction Ratio)	Theil's Inequality Coefficient	Bias	Variance	Covariance
Value	BP	0.266	0.615	0.003	0.616	0.006	0.166	0.829
	CP	0.218	0.685	0.000	0.681	0.012	0.637	0.351
	DY	0.187	0.631	0.001	0.563	0.007	0.221	0.772
	EY	0.265	0.692	0.000	0.598	0.009	0.345	0.646
Growth	C-6P	0.074	0.608	0.005	0.674	0.000	0.413	0.587
	C-12P	-0.129	0.746	0.000	0.676	0.010	0.651	0.339
	C-24P	-0.049	0.615	0.003	0.722	0.006	0.489	0.506
	CB	0.187	0.538	0.167	0.646	0.004	0.215	0.781
	D-12P	-0.008	0.569	0.048	0.739	0.008	0.404	0.588
	D-24P	0.060	0.646	0.000	0.666	0.000	0.186	0.814
	E-6P	0.082	0.531	0.215	0.737	0.004	0.354	0.642
	E-12P	-0.022	0.562	0.068	0.748	0.001	0.226	0.773
	E-24P	0.120	0.531	0.215	0.703	0.007	0.216	0.777
	PO	-0.051	0.608	0.005	0.732	0.000	0.540	0.460
	ROE	0.090	0.508	0.396	0.722	0.003	0.369	0.628
Momentum	MOM-1	-0.089	0.538	0.167	0.869	0.008	0.731	0.262
	MOM-3	0.043	0.538	0.167	0.724	0.008	0.648	0.343
	MOM-6	-0.001	0.669	0.000	0.682	0.006	0.639	0.355
	MOM-12	-0.018	0.708	0.000	0.710	0.008	0.581	0.411
	MOM-18	0.102	0.592	0.014	0.700	0.002	0.241	0.756

Appendix E

Appendix E contains material associated with chapter 8: Seasonality.

Appendix E.1: Mean Payoffs to Significant Attributes by Calendar Month

The table shows the mean payoffs in each calendar month for those attributes which are significant over the in-sample period from 31 January 1995 to 31 December 2001, the out-sample period from 31 January 2002 to 31 December 2005 or both. For any given attribute, the greater the difference between the monthly means, the more seasonality is present in the payoffs to that particular attribute. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Value	BP	0.002	0.002	0.003	0.005	-0.001	0.001	0.003	0.001	0.002	0.000	0.002	-0.001
	CP	0.004	0.001	0.004	0.006	0.001	0.003	0.005	0.001	0.001	0.003	0.004	0.000
	DY	-0.001	0.006	0.002	0.004	0.001	0.002	0.003	0.002	0.004	0.004	0.004	0.002
	EY	0.000	0.008	0.003	0.001	0.003	0.001	0.003	0.000	0.003	0.001	0.005	0.002
Growth	C-6P	0.001	0.002	0.002	0.004	0.005	0.004	0.002	-0.001	0.002	-0.001	0.000	0.003
	C-12P	0.005	0.001	0.002	0.004	0.005	0.005	0.001	0.004	0.003	-0.001	0.003	0.002
	C-24P	0.001	0.004	0.002	0.001	0.005	0.003	0.002	0.002	0.004	-0.001	0.001	0.002
	CB	0.003	-0.001	0.001	0.000	0.003	0.003	0.002	0.003	0.000	0.002	0.002	0.004
	D-12P	0.000	0.004	0.001	0.001	0.003	0.005	0.002	0.002	0.002	-0.002	0.001	0.002
	D-24P	0.000	0.004	0.002	0.001	0.002	0.003	0.003	0.003	0.003	-0.001	0.002	0.001
	E-6P	-0.001	0.003	-0.003	0.002	0.003	0.002	0.001	0.001	0.000	0.000	0.002	0.002
	E-12P	-0.002	0.005	-0.002	0.000	0.003	0.004	0.001	0.003	0.001	-0.002	0.001	0.001
	E-24P	-0.002	0.005	-0.002	-0.004	0.003	0.002	0.002	0.002	0.003	-0.001	0.000	0.002
	PO	-0.001	0.002	0.001	0.003	-0.002	0.002	0.001	0.001	0.002	0.004	0.003	0.000
	ROE	-0.001	0.005	-0.002	-0.001	0.005	0.001	0.001	0.001	0.001	0.001	0.003	0.003
Momentum	MOM-1	-0.002	-0.001	0.000	0.002	0.002	0.006	0.001	0.001	0.003	-0.002	0.008	0.006
	MOM-3	0.002	0.001	-0.002	-0.002	0.003	0.008	0.001	0.006	0.006	-0.001	0.003	0.010
	MOM-6	0.005	0.004	0.002	0.000	0.005	0.009	0.003	0.005	0.006	0.000	0.003	0.012
	MOM-12	0.007	0.005	0.001	-0.002	0.006	0.010	0.004	0.006	0.007	0.004	0.003	0.013
	MOM-18	0.002	0.004	-0.004	-0.006	0.003	0.008	0.005	0.006	0.007	-0.001	0.001	0.009

Appendix E.2: Median Payoffs to Significant Attributes by Calendar Month

The table shows the median payoffs in each calendar month for those attributes which are significant over the in-sample period from 31 January 1995 to 31 December 2001, the out-sample period from 31 January 2002 to 31 December 2005 or both. For any given attribute, the greater the difference between the monthly medians, the more seasonality is present in the payoffs to that particular attribute. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Value	BP	0.006	0.001	0.001	0.003	-0.002	0.004	0.003	0.000	0.002	0.002	0.002	0.001
	CP	0.005	0.001	0.003	0.004	0.001	0.005	0.004	0.002	0.000	0.003	0.003	0.001
	DY	-0.002	0.008	0.003	0.006	0.000	0.005	0.003	0.002	0.003	0.003	0.005	0.000
	EY	0.002	0.007	0.001	0.002	0.003	0.002	0.002	0.001	0.003	0.001	0.004	0.004
Growth	C-6P	0.000	0.001	0.002	0.001	0.003	0.003	0.001	0.000	0.001	-0.001	0.003	0.003
	C-12P	0.004	0.001	0.002	0.002	0.002	0.004	0.002	0.003	0.003	0.000	0.003	-0.001
	C-24P	0.001	0.005	0.001	0.003	0.002	0.003	0.003	0.003	0.008	-0.002	0.002	0.001
	CB	0.002	-0.001	-0.001	0.000	0.003	0.002	0.002	0.005	0.001	0.004	0.001	0.004
	D-12P	0.000	0.004	0.002	0.003	0.001	0.005	0.003	0.003	0.003	-0.003	0.003	0.002
	D-24P	-0.002	0.003	0.002	0.003	0.001	0.002	0.003	0.002	0.003	-0.001	0.001	0.000
	E-6P	0.000	0.003	-0.002	0.003	0.003	0.001	-0.001	0.001	0.003	0.001	0.002	0.002
	E-12P	-0.002	0.005	-0.002	-0.001	0.001	0.003	0.000	0.004	0.003	-0.003	0.001	0.000
	E-24P	-0.001	0.006	-0.003	-0.001	0.004	0.003	0.002	0.002	0.004	-0.002	0.001	0.004
	PO	-0.002	0.003	0.001	0.003	0.000	0.002	0.002	0.001	0.002	0.002	0.002	0.000
	ROE	-0.001	0.004	-0.001	0.000	0.003	0.002	-0.001	0.001	0.000	0.002	0.004	0.002
Momentum	MOM-1	0.001	-0.006	0.001	0.002	-0.001	0.004	0.003	0.000	0.003	0.002	0.009	0.006
	MOM-3	0.002	0.002	-0.002	0.000	0.000	0.003	-0.001	0.002	0.009	0.002	0.007	0.007
	MOM-6	0.007	0.008	0.002	-0.002	0.003	0.007	-0.001	0.004	0.005	0.003	0.010	0.011
	MOM-12	0.009	0.006	0.002	-0.004	0.004	0.009	0.002	0.004	0.010	0.009	0.006	0.010
	MOM-18	0.003	0.003	0.001	-0.003	0.000	0.007	0.002	0.005	0.010	0.000	0.007	0.006

Appendix E.3: T-Statistics for Payoffs to Significant Attributes after Excluding Calendar Months

The table shows the t-statistics of the payoffs to the significant attributes after the exclusion of certain calendar months. The attributes shown in grey are not significant at the 5% level over the entire sample and are therefore disregarded for the purpose of this analysis. All possible combinations of the six chosen months are excluded resulting in a total of 63 exclusion combinations. T-statistics which are still significant at the 5% level are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	Value				Growth											Critical
	BP	CP	DY	EY	C-6P	C-12P	C-24P	CB	D-12P	D-24P	E-6P	E-12P	E-24P	PO	ROE	T-Statistic
All	1.955	4.552	5.253	3.666	3.919	5.612	4.195	3.416	3.539	3.493	2.116	1.739	1.862	3.382	2.706	1.978
excl. Jan	1.652	4.224	5.745	4.230	3.954	5.015	4.123	3.437	3.513	3.627	2.347	1.971	2.169	3.896	3.007	1.980
excl. Mar	1.706	4.187	4.965	3.391	3.715	5.382	3.931	3.468	3.431	3.311	2.753	2.097	2.146	3.157	3.221	1.980
excl. Apr	1.498	4.113	4.758	3.619	3.455	5.182	4.627	3.607	3.718	3.903	1.827	1.666	2.839	2.901	3.154	1.980
excl. Jun	1.896	4.297	5.218	3.679	3.270	4.957	3.793	3.082	2.875	3.164	1.747	1.244	1.668	3.183	2.584	1.980
excl. Jul	1.065	3.902	4.943	3.352	3.669	5.481	3.957	3.198	3.259	3.076	2.032	1.591	1.611	3.259	2.670	1.980
excl. Dec	2.147	4.667	5.332	3.551	3.619	5.521	3.933	2.910	3.368	3.376	1.791	1.683	1.596	3.507	2.240	1.980
excl. Jan Mar	1.636	3.836	5.451	3.936	3.747	4.769	3.854	3.532	3.405	3.448	3.040	2.361	2.475	3.668	3.582	1.982
excl. Jan Apr	1.462	3.754	5.240	4.219	3.481	4.552	4.574	3.706	3.697	4.086	2.059	2.142	3.253	3.392	3.517	1.982
excl. Jan Jun	1.593	3.950	5.769	4.330	3.287	4.320	3.711	3.072	2.840	3.298	1.970	1.439	1.990	3.721	2.888	1.982
excl. Jan Jul	1.639	3.541	5.442	3.885	3.697	4.869	3.881	3.209	3.231	3.205	2.269	1.823	1.915	3.774	2.983	1.982
excl. Jan Dec	2.171	4.339	5.903	4.164	3.651	4.902	3.856	2.881	3.342	3.516	2.021	1.915	1.560	4.084	2.532	1.982
excl. Mar Apr	1.209	3.714	4.454	3.336	3.232	4.937	4.347	3.697	3.611	3.722	2.470	2.284	3.228	2.658	3.792	1.982
excl. Mar Jun	1.638	3.912	4.918	3.393	3.043	4.706	3.513	3.119	2.748	2.969	2.367	1.588	1.967	2.946	3.103	1.982
excl. Mar Jul	1.397	3.508	4.643	3.068	3.457	5.250	3.685	3.246	3.144	2.882	2.688	1.945	1.892	3.030	3.208	1.982
excl. Mar Dec	1.900	4.299	5.033	3.264	3.402	5.286	3.657	2.939	3.255	3.188	2.431	2.045	1.857	3.279	2.736	1.982
excl. Apr Jun	1.422	3.831	4.703	3.637	2.755	4.487	4.206	3.258	3.009	3.563	1.441	1.360	2.709	2.677	3.034	1.982
excl. Apr Jul	1.173	3.413	4.427	3.296	3.186	5.039	4.369	3.390	3.414	3.436	1.734	1.731	2.565	2.767	3.140	1.982
excl. Apr Dec	1.693	4.228	4.818	3.503	3.125	5.078	4.364	3.076	3.554	3.811	1.483	1.830	2.564	3.013	2.663	1.982
excl. Jun Jul	1.596	3.618	4.899	3.351	3.000	4.808	3.541	2.847	2.572	2.728	1.652	1.068	1.401	3.053	2.546	1.982
excl. Jun Dec	2.095	4.414	5.322	3.569	2.931	4.843	3.512	2.551	2.674	3.034	1.405	1.181	1.349	3.311	2.111	1.982
excl. Jul Dec	1.853	3.990	5.016	3.223	3.355	5.389	3.685	2.667	3.077	2.944	1.697	1.533	1.302	3.383	2.191	1.982
excl. Jan Mar Apr	1.146	3.323	4.928	3.916	3.252	4.288	4.288	3.877	3.591	3.912	2.761	2.570	3.696	3.142	4.255	1.984
excl. Jan Mar Jun	1.617	3.537	5.465	4.024	3.054	4.050	3.425	3.150	2.713	3.105	2.644	1.834	2.314	3.480	3.470	1.984
excl. Jan Mar Jul	1.350	3.118	5.135	3.578	3.482	4.621	3.603	3.306	3.116	3.012	2.987	2.203	2.217	3.540	3.591	1.984
excl. Jan Mar Dec	1.910	3.945	5.600	3.855	3.429	4.649	3.573	2.947	3.229	3.331	2.719	2.304	2.193	3.855	3.086	1.984
excl. Jan Apr Jun	1.383	3.448	5.244	4.339	2.757	3.808	4.142	3.325	2.976	3.749	1.664	1.507	3.163	3.187	3.403	1.984
excl. Jan Apr Jul	1.103	3.012	4.913	3.862	3.203	4.392	4.311	3.490	3.390	3.610	1.971	1.987	2.976	3.256	3.525	1.984
excl. Jan Apr Dec	1.689	3.868	5.380	4.161	3.145	4.422	4.307	3.121	3.532	4.008	1.713	2.090	2.997	3.567	3.015	1.984
excl. Jan Jun Jul	1.568	3.233	5.461	3.967	3.007	4.154	3.454	2.822	2.534	2.856	1.881	1.313	1.720	3.592	2.862	1.984
excl. Jan Jun Dec	2.122	4.067	5.978	4.291	2.941	4.179	3.424	2.481	2.638	3.175	1.626	1.403	1.630	3.923	2.404	1.984
excl. Jan Jul Dec	1.852	3.625	5.600	3.800	3.378	4.754	3.602	2.620	3.047	3.078	1.933	1.765	1.612	3.965	2.494	1.984
excl. Mar Apr Jun	1.120	3.407	4.384	3.342	2.502	4.217	3.905	3.334	2.879	3.366	2.065	1.741	3.136	2.420	3.681	1.984
excl. Mar Apr Jul	0.858	2.977	4.110	3.004	2.954	4.791	4.079	3.481	3.299	3.236	2.396	2.128	2.951	2.520	3.820	1.984
excl. Mar Apr Dec	1.406	3.824	4.501	3.207	2.884	4.826	4.069	3.141	3.442	3.625	2.127	2.234	2.971	2.767	3.277	1.984
excl. Mar Jun Jul	1.318	3.199	4.585	3.053	2.763	4.553	3.253	2.879	2.438	2.519	2.289	1.431	1.696	2.811	3.088	1.984
excl. Mar Jun Dec	1.839	4.025	5.010	3.268	2.685	4.584	3.218	2.562	2.541	2.832	2.025	1.529	1.655	3.070	2.607	1.984
excl. Mar Jul Dec	1.566	3.589	4.704	2.925	3.128	5.154	3.401	2.688	2.957	2.742	2.355	1.694	1.588	3.150	2.708	1.984
excl. Apr Jun Jul	1.084	3.095	4.358	3.298	2.461	4.323	3.930	3.022	2.675	3.067	1.336	1.196	2.414	2.535	3.018	1.984
excl. Apr Jun Dec	1.624	3.949	4.785	3.527	2.373	4.356	3.920	2.698	2.807	3.457	1.077	1.296	2.416	2.791	2.532	1.984
excl. Apr Jul Dec	1.112	3.236	4.198	3.125	3.021	4.778	4.143	3.214	3.238	3.258	1.644	1.641	2.432	2.624	2.978	1.984
excl. Jun Jul Dec	1.790	3.704	4.997	3.224	2.642	4.691	3.249	2.289	2.357	2.582	1.299	1.023	1.065	3.181	2.058	1.984
excl. Jan Mar Apr Jun	1.049	2.984	4.918	4.024	2.496	3.515	3.833	3.482	2.845	3.559	2.344	2.016	3.660	2.921	4.160	1.987
excl. Jan Mar Apr Jul	0.750	2.535	4.585	3.546	2.964	4.125	4.014	3.678	3.275	3.416	2.700	2.415	3.416	2.999	4.327	1.987
excl. Jan Mar Apr Dec	1.276	3.431	5.056	3.844	2.897	4.149	4.005	3.264	3.421	3.830	2.419	2.527	3.466	3.315	3.727	1.987
excl. Jan Mar Jun Jul	1.265	2.780	5.143	3.645	2.763	3.880	3.158	2.898	2.399	2.648	2.577	1.676	2.039	3.344	3.479	1.987
excl. Jan Mar Jun Dec	1.851	3.648	5.667	3.969	2.687	3.899	3.122	2.523	2.502	2.974	2.302	1.777	2.013	3.682	2.962	1.987
excl. Jan Mar Jul Dec	1.566	3.193	5.284	3.476	3.146	4.499	3.311	2.681	2.927	2.877	2.656	2.153	1.921	3.731	3.077	1.987
excl. Jan Apr Jun Jul	1.005	2.661	4.908	3.962	2.451	3.625	3.860	3.083	2.637	3.243	1.563	1.443	2.864	3.043	3.410	1.987
excl. Jan Apr Jun Dec	1.620	3.564	5.436	4.317	2.364	3.644	3.850	2.698	2.771	3.659	1.297	1.546	2.896	3.376	2.888	1.987
excl. Jan Apr Jul Dec	1.321	3.089	5.051	3.784	2.847	4.259	4.030	2.865	3.209	3.508	1.613	1.932	2.791	3.433	3.004	1.987
excl. Jan Jun Jul Dec	1.790	3.315	5.677	3.905	2.640	4.008	3.154	2.191	2.316	2.714	1.525	1.250	1.292	3.798	2.362	1.987
excl. Mar Apr Jun Jul	0.752	2.626	4.024	2.991	2.196	4.048	3.617	3.096	2.534	2.848	1.976	1.575	2.836	2.272	3.710	1.988
excl. Mar Apr Jun Dec	1.324	3.518	4.452	3.216	2.096	4.074	3.601	2.743	2.668	3.253	1.699	1.681	2.867	2.529	3.152	1.988
excl. Mar Apr Jul Dec	1.047	3.050	4.144	2.858	2.586	4.680	3.787	2.891	3.114	3.114	2.040	2.075	2.673	2.626	3.285	1.988
excl. Mar Jun Jul Dec	1.513	3.278	4.670	2.911	2.385	4.429	2.946	2.288	2.214	2.362	1.935	1.368	1.396	2.935	2.576	1.988
excl. Apr Jun Jul Dec	1.279	3.175	4.431	3.170	2.055	4.187	3.629	2.429	2.453	2.935	0.958	1.123	2.097	2.648	2.498	1.988
excl. Jan Mar Apr Jun Jul	0.627	2.141	4.565	3.630	2.176	3.325	3.537	3.254	2.495	3.030	2.267	1.849	3.358	2.767	4.241	1.991
excl. Jan Mar Apr Jun Dec	1.290	3.091	5.099	3.986	2.075	3.337	3.521	2.817	2.631	3.463	1.977	1.920	3.431	3.106	3.616	1.991
excl. Jan Mar Apr Jul Dec	0.968	2.599	4.709	3.450	2.586	3.981	3.715	3.019	3.088	3.307	2.344	2.369	3.168	3.174	3.778	1.991
excl. Jan Mar Jun Jul Dec	1.491	2.850	5.351	3.565	2.374	3.723	2.842	2.222	2.172	2.496	2.223	1.617	1.719	3.551	2.952	1.991
excl. Jan Apr Jun Jul Dec	1.233	2.733	5.104	3.916	2.030	3.453	3.550	2.406	2.411	3.125	1.182	1.378	2.572	3.232	2.875	1.991
excl. Mar Apr Jun Jul Dec	0.946	2.693	4.079	2.846	1.763	3.901	3.294	2.464	2.300	2.704	1.596	1.512	2.542	2.378	3.160	1.992
excl. Jan Mar Apr Jun Jul Dec	0.855	2.195	4.747	3.564	1.724	3.139	3.204	2.529	2.257	2.901	1.884	1.791	3.103	2.954	3.674	1.997

Appendix E.3: T-Statistics for Payoffs to Significant Attributes after Excluding Calendar Months

-continued.

	Momentum					Critical
	MOM-1	MOM-3	MOM-6	MOM-12	MOM-18	T-Statistic
All	**2.139**	**2.666**	**3.733**	**4.558**	**2.335**	1.978
excl. Jan	**2.427**	**2.702**	**3.586**	**4.349**	**2.319**	1.980
excl. Mar	**2.229**	**2.923**	**3.702**	**4.639**	**2.720**	1.980
excl. Apr	**2.079**	**2.902**	**3.867**	**4.989**	**3.137**	1.980
excl. Jun	1.660	**2.180**	**3.253**	**4.014**	1.807	1.980
excl. Jul	**2.048**	**2.653**	**3.609**	**4.344**	**2.017**	1.980
excl. Dec	1.724	**1.997**	**2.953**	**3.797**	1.717	1.980
excl. Jan Mar	**2.542**	**2.986**	**3.554**	**4.435**	**2.725**	1.982
excl. Jan Apr	**2.384**	**2.964**	**3.729**	**4.808**	**3.174**	1.982
excl. Jan Jun	1.939	**2.194**	**3.082**	**3.776**	1.771	1.982
excl. Jan Jul	**2.341**	**2.694**	**3.456**	**4.123**	**1.989**	1.982
excl. Jan Dec	**2.016**	**1.991**	**2.767**	**3.546**	1.678	1.982
excl. Mar Apr	**2.175**	**3.179**	**3.844**	**5.114**	**3.660**	1.982
excl. Mar Jun	1.738	**2.442**	**3.209**	**4.083**	**2.175**	1.982
excl. Mar Jul	**2.139**	**2.918**	**3.577**	**4.424**	**2.392**	1.982
excl. Mar Dec	1.808	**2.245**	**2.900**	**3.853**	**2.085**	1.982
excl. Apr Jun	1.578	**2.419**	**3.373**	**4.442**	**2.568**	1.982
excl. Apr Jul	**1.985**	**2.897**	**3.746**	**4.781**	**2.794**	1.982
excl. Apr Dec	1.645	**2.221**	**3.054**	**4.197**	**2.476**	1.982
excl. Jun Jul	1.556	**2.157**	**3.114**	**3.780**	1.474	1.982
excl. Jun Dec	1.194	1.454	**2.434**	**3.203**	1.157	1.982
excl. Jul Dec	1.619	1.968	**2.805**	**3.559**	1.381	1.982
excl. Jan Mar Apr	**2.509**	**3.275**	**3.707**	**4.948**	**3.746**	1.984
excl. Jan Mar Jun	**2.040**	**2.484**	**3.036**	**3.848**	**2.159**	1.984
excl. Jan Mar Jul	**2.458**	**2.989**	**3.423**	**4.208**	**2.384**	1.984
excl. Jan Mar Dec	**2.128**	**2.263**	**2.709**	**3.603**	**2.065**	1.984
excl. Jan Apr Jun	1.872	**2.460**	**3.209**	**4.233**	**2.580**	1.984
excl. Jan Apr Jul	**2.296**	**2.967**	**3.603**	**4.590**	**2.816**	1.984
excl. Jan Apr Dec	1.956	**2.238**	**2.872**	**3.970**	**2.484**	1.984
excl. Jan Jun Jul	1.838	**2.173**	**2.934**	**3.526**	1.425	1.984
excl. Jan Jun Dec	1.474	1.411	**2.217**	**2.912**	1.095	1.984
excl. Jan Jul Dec	1.917	1.963	**2.609**	**3.292**	1.328	1.984
excl. Mar Apr Jun	1.659	**2.702**	**3.337**	**4.557**	**3.068**	1.984
excl. Mar Apr Jul	**2.082**	**3.187**	**3.724**	**4.910**	**3.304**	1.984
excl. Mar Apr Dec	1.735	**2.487**	**3.006**	**4.293**	**2.975**	1.984
excl. Mar Jun Jul	1.632	**2.428**	**3.068**	**3.846**	1.831	1.984
excl. Mar Jun Dec	1.261	1.706	**2.366**	**3.243**	1.506	1.984
excl. Mar Jul Dec	1.703	**2.223**	**2.749**	**3.611**	1.736	1.984
excl. Apr Jun Jul	1.467	**2.403**	**3.235**	**4.212**	**2.207**	1.984
excl. Apr Jun Dec	1.085	1.679	**2.518**	**3.596**	1.868	1.984
excl. Apr Jul Dec	1.882	**2.747**	**3.552**	**4.534**	**2.649**	1.984
excl. Jun Jul Dec	1.071	1.411	**2.268**	**2.939**	0.802	1.984
excl. Jan Mar Apr Jun	1.982	**2.780**	**3.172**	**4.361**	**3.125**	1.987
excl. Jan Mar Apr Jul	**2.424**	**3.296**	**3.582**	**4.735**	**3.374**	1.987
excl. Jan Mar Apr Dec	**2.078**	**2.535**	**2.820**	**4.074**	**3.029**	1.987
excl. Jan Mar Jun Jul	1.940	**2.477**	**2.885**	**3.595**	1.800	1.987
excl. Jan Mar Jun Dec	1.567	1.690	**2.142**	**2.950**	1.460	1.987
excl. Jan Mar Jul Dec	**2.030**	**2.246**	**2.548**	**3.344**	1.701	1.987
excl. Jan Apr Jun Jul	1.766	**2.452**	**3.064**	**3.988**	**2.201**	1.987
excl. Jan Apr Jun Dec	1.380	1.661	**2.302**	**3.328**	1.846	1.987
excl. Jan Apr Jul Dec	1.851	**2.220**	**2.714**	**3.719**	**2.100**	1.987
excl. Jan Jun Jul Dec	1.354	1.366	**2.038**	**2.627**	0.724	1.987
excl. Mar Apr Jun Jul	1.548	**2.699**	**3.198**	**4.328**	**2.692**	1.988
excl. Mar Apr Jun Dec	1.154	1.950	**2.454**	**3.675**	**2.341**	1.988
excl. Mar Apr Jul Dec	1.624	**2.475**	**2.856**	**4.056**	**2.593**	1.988
excl. Mar Jun Jul Dec	1.136	1.671	**2.195**	**2.973**	1.138	1.988
excl. Apr Jun Jul Dec	0.953	1.643	**2.350**	**3.332**	1.480	1.988
excl. Jan Mar Apr Jun Jul	1.878	**2.790**	**3.025**	**4.118**	**2.729**	1.991
excl. Jan Mar Apr Jun Dec	1.481	1.966	**2.230**	**3.413**	**2.359**	1.991
excl. Jan Mar Apr Jul Dec	1.976	**2.531**	**2.659**	**3.821**	**2.627**	1.991
excl. Jan Mar Jun Jul Dec	1.446	1.656	1.956	**2.656**	1.074	1.991
excl. Jan Apr Jun Jul Dec	1.251	1.626	**2.119**	**3.042**	1.436	1.991
excl. Mar Apr Jun Jul Dec	1.018	1.924	**2.280**	**3.407**	1.934	1.992
excl. Jan Mar Apr Jun Jul Dec	1.351	1.945	**2.041**	**3.121**	1.927	1.997

Appendix E.4: Correlations between the Monthly Means and Standard Deviations of Payoffs to Significant Attributes

The table shows the Pearson (1896) correlations between the mean payoffs and the standard deviations in each calendar month for the significant attributes. Correlations which are significant at the 5% level, as determined by the test statistic of equation 7.6, are displayed in bold. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Style Group	Attribute	Correlation
Value	BP	0.176
	CP	-0.123
	DY	-0.149
	EY	0.022
Growth	C-6P	0.057
	C-12P	0.021
	C-24P	0.332
	CB	-0.033
	D-12P	-0.309
	D-24P	-0.324
	E-6P	-0.284
	E-12P	-0.199
	E-24P	-0.449
	PO	-0.174
	ROE	-0.236
Momentum	MOM-1	-0.327
	MOM-3	0.088
	MOM-6	-0.453
	MOM-12	-0.111
	MOM-18	**-0.670**

Appendix E.5: Contrasts between Mean Calendar Month Payoffs

The tables in this appendix show the contrasts between the payoffs to the significant attributes for every possible pair of months. The contrast for any particular pair of months is calculated by taking the absolute difference between the mean payoffs to the relevant attribute in the two calendar months. None of the contrasts are significantly different at either the 5% level or 10% level as determined by Scheffé's S-statistic. The critical S-statistics are displayed below the tables. The monthly payoffs are obtained from the univariate cross-sectional regression analyses of chapter 6, which are performed on unadjusted returns data over the entire sample period from 31 January 1995 to 31 December 2005. All the attributes listed produce significant payoffs at the 5% level when tested with Student's (1908) t-test in either the in-sample period, the out-sample period or both and are standardised before regression analysis. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

Appendix E.5.1: Contrasts between Mean Calendar Month Payoffs to BP

BP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0002											
Mar	0.0013	0.0011										
Apr	0.0036	0.0034	0.0023									
May	0.0030	0.0032	0.0043	0.0066								
Jun	0.0006	0.0008	0.0019	0.0042	0.0024							
Jul	0.0013	0.0011	0.0001	0.0023	0.0043	0.0020						
Aug	0.0009	0.0011	0.0022	0.0045	0.0021	0.0003	0.0023					
Sep	0.0003	0.0001	0.0010	0.0033	0.0033	0.0009	0.0010	0.0012				
Oct	0.0020	0.0022	0.0033	0.0056	0.0010	0.0014	0.0033	0.0011	0.0023			
Nov	0.0003	0.0001	0.0009	0.0032	0.0033	0.0010	0.0010	0.0013	0.0000	0.0023		
Dec	0.0028	0.0030	0.0040	0.0064	0.0002	0.0021	0.0041	0.0018	0.0031	0.0008	0.0031	

Critical S 5%	Jan & Non Jan	0.018	**Critical S 5%**	Non Jan & Non Jan	0.017
Critical S 10%	Jan & Non Jan	0.017	**Critical S 10%**	Non Jan & Non Jan	0.016

Appendix E.5.2: Contrasts between Mean Calendar Month Payoffs to CP

CP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0030											
Mar	0.0003	0.0027										
Apr	0.0012	0.0042	0.0015									
May	0.0031	0.0001	0.0028	0.0043								
Jun	0.0011	0.0019	0.0008	0.0023	0.0020							
Jul	0.0007	0.0037	0.0010	0.0005	0.0038	0.0018						
Aug	0.0034	0.0004	0.0030	0.0045	0.0002	0.0022	0.0040					
Sep	0.0034	0.0004	0.0030	0.0045	0.0002	0.0022	0.0040	0.0000				
Oct	0.0011	0.0019	0.0008	0.0023	0.0020	0.0000	0.0018	0.0022	0.0022			
Nov	0.0006	0.0024	0.0002	0.0017	0.0026	0.0006	0.0012	0.0028	0.0028	0.0006		
Dec	0.0040	0.0009	0.0036	0.0051	0.0008	0.0028	0.0046	0.0006	0.0006	0.0028	0.0034	

Critical S 5%	Jan & Non Jan	0.014	**Critical S 5%**	Non Jan & Non Jan	0.014
Critical S 10%	Jan & Non Jan	0.013	**Critical S 10%**	Non Jan & Non Jan	0.013

Appendix E.5.3: Contrasts between Mean Calendar Month Payoffs to DY

DY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0068											
Mar	0.0030	0.0038										
Apr	0.0051	0.0017	0.0020									
May	0.0019	0.0049	0.0011	0.0032								
Jun	0.0027	0.0041	0.0003	0.0024	0.0008							
Jul	0.0037	0.0031	0.0007	0.0013	0.0018	0.0010						
Aug	0.0031	0.0037	0.0000	0.0020	0.0012	0.0004	0.0007					
Sep	0.0046	0.0022	0.0015	0.0005	0.0027	0.0019	0.0009	0.0015				
Oct	0.0051	0.0017	0.0021	0.0000	0.0032	0.0024	0.0014	0.0020	0.0005			
Nov	0.0050	0.0018	0.0020	0.0001	0.0031	0.0023	0.0013	0.0019	0.0004	0.0001		
Dec	0.0022	0.0046	0.0009	0.0029	0.0003	0.0005	0.0016	0.0009	0.0024	0.0029	0.0028	

Critical S 5%	Jan & Non Jan	0.013	**Critical S 5%**	Non Jan & Non Jan	0.013
Critical S 10%	Jan & Non Jan	0.012	**Critical S 10%**	Non Jan & Non Jan	0.012

Appendix E.5.4: Contrasts between Mean Calendar Month Payoffs to EY

EY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0077											
Mar	0.0026	0.0050										
Apr	0.0011	0.0066	0.0015									
May	0.0029	0.0048	0.0003	0.0018								
Jun	0.0014	0.0063	0.0013	0.0002	0.0016							
Jul	0.0028	0.0048	0.0002	0.0017	0.0001	0.0015						
Aug	0.0001	0.0077	0.0027	0.0012	0.0030	0.0014	0.0029					
Sep	0.0030	0.0047	0.0003	0.0018	0.0000	0.0016	0.0001	0.0030				
Oct	0.0006	0.0071	0.0021	0.0006	0.0024	0.0008	0.0023	0.0006	0.0024			
Nov	0.0047	0.0030	0.0020	0.0035	0.0017	0.0033	0.0018	0.0047	0.0017	0.0041		
Dec	0.0021	0.0056	0.0005	0.0010	0.0008	0.0007	0.0007	0.0022	0.0008	0.0015	0.0025	

Critical S 5%	Jan & Non Jan	0.015	**Critical S 5%**	Non Jan & Non Jan	0.015
Critical S 10%	Jan & Non Jan	0.014	**Critical S 10%**	Non Jan & Non Jan	0.014

Appendix E.5.5: Contrasts between Mean Calendar Month Payoffs to C-6P

C-6P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0012											
Mar	0.0009	0.0003										
Apr	0.0029	0.0017	0.0020									
May	0.0043	0.0030	0.0033	0.0013								
Jun	0.0038	0.0026	0.0029	0.0009	0.0004							
Jul	0.0010	0.0002	0.0000	0.0020	0.0033	0.0029						
Aug	0.0016	0.0028	0.0025	0.0045	0.0058	0.0054	0.0025					
Sep	0.0012	0.0000	0.0002	0.0018	0.0031	0.0027	0.0002	0.0027				
Oct	0.0017	0.0029	0.0026	0.0046	0.0059	0.0055	0.0026	0.0001	0.0028			
Nov	0.0002	0.0015	0.0012	0.0032	0.0045	0.0041	0.0012	0.0013	0.0014	0.0014		
Dec	0.0019	0.0007	0.0010	0.0010	0.0023	0.0019	0.0010	0.0035	0.0008	0.0036	0.0022	

Critical S 5%	Jan & Non Jan	0.010	**Critical S 5%**	Non Jan & Non Jan	0.010
Critical S 10%	Jan & Non Jan	0.010	**Critical S 10%**	Non Jan & Non Jan	0.009

Appendix E.5.6: Contrasts between Mean Calendar Month Payoffs to C-12P

C-12P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0035											
Mar	0.0031	0.0004										
Apr	0.0009	0.0026	0.0022									
May	0.0003	0.0032	0.0027	0.0005								
Jun	0.0005	0.0040	0.0036	0.0014	0.0009							
Jul	0.0037	0.0002	0.0006	0.0028	0.0033	0.0042						
Aug	0.0013	0.0022	0.0018	0.0004	0.0009	0.0018	0.0024					
Sep	0.0014	0.0021	0.0017	0.0005	0.0011	0.0019	0.0022	0.0001				
Oct	0.0058	0.0023	0.0027	0.0049	0.0055	0.0063	0.0021	0.0045	0.0044			
Nov	0.0021	0.0014	0.0010	0.0012	0.0018	0.0026	0.0016	0.0008	0.0007	0.0037		
Dec	0.0032	0.0003	0.0001	0.0023	0.0029	0.0037	0.0005	0.0019	0.0018	0.0026	0.0011	

Critical S 5%	Jan & Non Jan	0.011	**Critical S 5%**	Non Jan & Non Jan	0.011
Critical S 10%	Jan & Non Jan	0.010	**Critical S 10%**	Non Jan & Non Jan	0.010

Appendix E.5.7: Contrasts between Mean Calendar Month Payoffs to C-24P

C-24P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0025											
Mar	0.0011	0.0014										
Apr	0.0001	0.0024	0.0010									
May	0.0037	0.0012	0.0026	0.0036								
Jun	0.0023	0.0001	0.0013	0.0022	0.0014							
Jul	0.0008	0.0017	0.0003	0.0006	0.0029	0.0016						
Aug	0.0014	0.0011	0.0003	0.0013	0.0023	0.0010	0.0006					
Sep	0.0030	0.0005	0.0019	0.0028	0.0007	0.0006	0.0022	0.0016				
Oct	0.0024	0.0049	0.0035	0.0025	0.0061	0.0047	0.0032	0.0038	0.0054			
Nov	0.0001	0.0026	0.0012	0.0002	0.0038	0.0024	0.0008	0.0015	0.0030	0.0023		
Dec	0.0013	0.0011	0.0003	0.0012	0.0024	0.0010	0.0006	0.0000	0.0016	0.0037	0.0014	

Critical S 5%	Jan & Non Jan	0.012	**Critical S 5%**	Non Jan & Non Jan	0.012
Critical S 10%	Jan & Non Jan	0.012	**Critical S 10%**	Non Jan & Non Jan	0.011

Appendix E.5.8: Contrasts between Mean Calendar Month Payoffs to CB

CB	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0032											
Mar	0.0017	0.0015										
Apr	0.0021	0.0011	0.0004									
May	0.0001	0.0033	0.0018	0.0022								
Jun	0.0000	0.0032	0.0017	0.0021	0.0001							
Jul	0.0005	0.0027	0.0012	0.0016	0.0006	0.0005						
Aug	0.0003	0.0035	0.0020	0.0024	0.0002	0.0003	0.0008					
Sep	0.0026	0.0006	0.0009	0.0005	0.0027	0.0026	0.0021	0.0029				
Oct	0.0007	0.0026	0.0010	0.0015	0.0008	0.0006	0.0001	0.0009	0.0020			
Nov	0.0006	0.0026	0.0011	0.0015	0.0007	0.0006	0.0001	0.0009	0.0020	0.0000		
Dec	0.0012	0.0044	0.0029	0.0033	0.0011	0.0012	0.0017	0.0009	0.0038	0.0018	0.0018	

Critical S 5%	Jan & Non Jan	0.012	**Critical S 5%**	Non Jan & Non Jan	0.012
Critical S 10%	Jan & Non Jan	0.011	**Critical S 10%**	Non Jan & Non Jan	0.011

Appendix E.5.9: Contrasts between Mean Calendar Month Payoffs to D-12P

D-12P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0032											
Mar	0.0007	0.0025										
Apr	0.0008	0.0024	0.0001									
May	0.0023	0.0009	0.0016	0.0015								
Jun	0.0046	0.0014	0.0039	0.0038	0.0023							
Jul	0.0016	0.0016	0.0009	0.0008	0.0008	0.0030						
Aug	0.0017	0.0014	0.0011	0.0009	0.0006	0.0028	0.0002					
Sep	0.0017	0.0014	0.0011	0.0009	0.0006	0.0028	0.0002	0.0000				
Oct	0.0019	0.0051	0.0026	0.0027	0.0042	0.0065	0.0035	0.0037	0.0037			
Nov	0.0008	0.0024	0.0001	0.0000	0.0015	0.0038	0.0008	0.0009	0.0009	0.0027		
Dec	0.0014	0.0018	0.0007	0.0006	0.0009	0.0032	0.0002	0.0004	0.0004	0.0033	0.0006	

Critical S 5%	Jan & Non Jan	0.011	**Critical S 5%**	Non Jan & Non Jan	0.011
Critical S 10%	Jan & Non Jan	0.011	**Critical S 10%**	Non Jan & Non Jan	0.010

Appendix E.5.10: Contrasts between Mean Calendar Month Payoffs to D-24P

D-24P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0047											
Mar	0.0021	0.0025										
Apr	0.0013	0.0033	0.0008									
May	0.0025	0.0022	0.0004	0.0011								
Jun	0.0032	0.0014	0.0011	0.0019	0.0008							
Jul	0.0034	0.0013	0.0013	0.0020	0.0009	0.0001						
Aug	0.0031	0.0015	0.0010	0.0018	0.0006	0.0001	0.0002					
Sep	0.0036	0.0011	0.0014	0.0022	0.0011	0.0003	0.0002	0.0004				
Oct	0.0004	0.0051	0.0026	0.0018	0.0029	0.0037	0.0038	0.0036	0.0040			
Nov	0.0021	0.0026	0.0001	0.0007	0.0004	0.0012	0.0013	0.0011	0.0015	0.0025		
Dec	0.0019	0.0027	0.0002	0.0006	0.0006	0.0013	0.0015	0.0012	0.0016	0.0024	0.0001	

Critical S 5%	Jan & Non Jan	0.012	**Critical S 5%**	Non Jan & Non Jan	0.012
Critical S 10%	Jan & Non Jan	0.011	**Critical S 10%**	Non Jan & Non Jan	0.011

Appendix E.5.11: Contrasts between Mean Calendar Month Payoffs to E-6P

E-6P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0037											
Mar	0.0016	0.0053										
Apr	0.0031	0.0006	0.0047									
May	0.0036	0.0001	0.0052	0.0005								
Jun	0.0034	0.0003	0.0050	0.0003	0.0002							
Jul	0.0018	0.0019	0.0034	0.0013	0.0018	0.0016						
Aug	0.0022	0.0016	0.0037	0.0010	0.0015	0.0013	0.0003					
Sep	0.0012	0.0025	0.0028	0.0019	0.0024	0.0022	0.0006	0.0010				
Oct	0.0008	0.0029	0.0024	0.0023	0.0028	0.0026	0.0010	0.0013	0.0004			
Nov	0.0033	0.0004	0.0049	0.0002	0.0003	0.0001	0.0015	0.0011	0.0021	0.0025		
Dec	0.0033	0.0004	0.0049	0.0002	0.0003	0.0001	0.0015	0.0012	0.0021	0.0025	0.0000	

Critical S 5%	Jan & Non Jan	0.011	**Critical S 5%**	Non Jan & Non Jan	0.011
Critical S 10%	Jan & Non Jan	0.011	**Critical S 10%**	Non Jan & Non Jan	0.010

Appendix E.5.12: Contrasts between Mean Calendar Month Payoffs to E-12P

E-12P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0065											
Mar	0.0005	0.0070										
Apr	0.0013	0.0051	0.0018									
May	0.0045	0.0020	0.0050	0.0031								
Jun	0.0052	0.0012	0.0057	0.0039	0.0008							
Jul	0.0027	0.0038	0.0032	0.0014	0.0018	0.0025						
Aug	0.0047	0.0018	0.0052	0.0034	0.0002	0.0005	0.0020					
Sep	0.0023	0.0042	0.0028	0.0009	0.0022	0.0030	0.0004	0.0024				
Oct	0.0008	0.0073	0.0003	0.0022	0.0053	0.0061	0.0035	0.0055	0.0031			
Nov	0.0027	0.0038	0.0032	0.0014	0.0018	0.0025	0.0000	0.0020	0.0004	0.0035		
Dec	0.0021	0.0044	0.0026	0.0007	0.0024	0.0032	0.0006	0.0026	0.0002	0.0029	0.0006	

Critical S 5%	Jan & Non Jan	0.013	**Critical S 5%**	Non Jan & Non Jan	0.013
Critical S 10%	Jan & Non Jan	0.013	**Critical S 10%**	Non Jan & Non Jan	0.012

Appendix E.5.13: Contrasts between Mean Calendar Month Payoffs to E-24P

E-24P	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0072											
Mar	0.0003	0.0069										
Apr	0.0021	0.0093	0.0024									
May	0.0052	0.0020	0.0048	0.0073								
Jun	0.0038	0.0034	0.0035	0.0059	0.0014							
Jul	0.0037	0.0035	0.0033	0.0058	0.0015	0.0001						
Aug	0.0039	0.0033	0.0035	0.0060	0.0013	0.0001	0.0002					
Sep	0.0051	0.0021	0.0047	0.0072	0.0001	0.0013	0.0014	0.0012				
Oct	0.0012	0.0060	0.0009	0.0033	0.0039	0.0026	0.0025	0.0027	0.0039			
Nov	0.0022	0.0050	0.0019	0.0043	0.0030	0.0016	0.0015	0.0017	0.0029	0.0010		
Dec	0.0043	0.0029	0.0040	0.0064	0.0009	0.0005	0.0006	0.0004	0.0008	0.0031	0.0021	

Critical S 5%	Jan & Non Jan	0.012	**Critical S 5%**	Non Jan & Non Jan	0.012
Critical S 10%	Jan & Non Jan	0.011	**Critical S 10%**	Non Jan & Non Jan	0.011

Appendix E.5.14: Contrasts between Mean Calendar Month Payoffs to PO

PO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0026											
Mar	0.0020	0.0006										
Apr	0.0035	0.0009	0.0015									
May	0.0011	0.0038	0.0032	0.0046								
Jun	0.0022	0.0004	0.0002	0.0012	0.0034							
Jul	0.0014	0.0013	0.0006	0.0021	0.0025	0.0009						
Aug	0.0020	0.0006	0.0000	0.0015	0.0031	0.0003	0.0006					
Sep	0.0025	0.0001	0.0005	0.0009	0.0037	0.0003	0.0012	0.0005				
Oct	0.0046	0.0020	0.0026	0.0011	0.0057	0.0024	0.0032	0.0026	0.0021			
Nov	0.0033	0.0007	0.0013	0.0002	0.0045	0.0011	0.0019	0.0013	0.0008	0.0013		
Dec	0.0006	0.0020	0.0014	0.0029	0.0017	0.0017	0.0008	0.0014	0.0019	0.0040	0.0027	

Critical S 5%	Jan & Non Jan	0.009	**Critical S 5%**	Non Jan & Non Jan	0.009
Critical S 10%	Jan & Non Jan	0.009	**Critical S 10%**	Non Jan & Non Jan	0.008

Appendix E.5.15: Contrasts between Mean Calendar Month Payoffs to ROE

ROE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0059											
Mar	0.0004	0.0064										
Apr	0.0001	0.0058	0.0006									
May	0.0058	0.0002	0.0062	0.0057								
Jun	0.0021	0.0038	0.0026	0.0020	0.0036							
Jul	0.0019	0.0041	0.0023	0.0018	0.0039	0.0003						
Aug	0.0023	0.0036	0.0027	0.0022	0.0035	0.0002	0.0004					
Sep	0.0018	0.0041	0.0022	0.0017	0.0040	0.0003	0.0001	0.0005				
Oct	0.0022	0.0038	0.0026	0.0020	0.0036	0.0000	0.0003	0.0001	0.0004			
Nov	0.0045	0.0014	0.0049	0.0044	0.0013	0.0024	0.0026	0.0022	0.0027	0.0023		
Dec	0.0042	0.0017	0.0046	0.0041	0.0016	0.0021	0.0023	0.0019	0.0024	0.0020	0.0003	

Critical S 5%	Jan & Non Jan	0.010	**Critical S 5%**	Non Jan & Non Jan	0.010
Critical S 10%	Jan & Non Jan	0.010	**Critical S 10%**	Non Jan & Non Jan	0.009

Appendix E.5.16: Contrasts between Mean Calendar Month Payoffs to MOM-1

MOM-1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0006											
Mar	0.0019	0.0013										
Apr	0.0036	0.0031	0.0017									
May	0.0036	0.0030	0.0017	0.0000								
Jun	0.0080	0.0074	0.0061	0.0044	0.0044							
Jul	0.0035	0.0029	0.0015	0.0002	0.0002	0.0046						
Aug	0.0033	0.0028	0.0014	0.0003	0.0003	0.0047	0.0001					
Sep	0.0047	0.0041	0.0028	0.0011	0.0011	0.0033	0.0012	0.0014				
Oct	0.0002	0.0008	0.0021	0.0038	0.0038	0.0082	0.0036	0.0035	0.0049			
Nov	0.0101	0.0096	0.0082	0.0065	0.0065	0.0021	0.0067	0.0068	0.0054	0.0103		
Dec	0.0078	0.0072	0.0059	0.0041	0.0041	0.0002	0.0043	0.0044	0.0031	0.0080	0.0024	

Critical S 5%	Jan & Non Jan	0.021	**Critical S 5%**	Non Jan & Non Jan	0.020
Critical S 10%	Jan & Non Jan	0.019	**Critical S 10%**	Non Jan & Non Jan	0.019

Appendix E.5.17: Contrasts between Mean Calendar Month Payoffs to MOM-3

MOM-3	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0009											
Mar	0.0045	0.0036										
Apr	0.0041	0.0031	0.0004									
May	0.0009	0.0018	0.0054	0.0050								
Jun	0.0059	0.0068	0.0104	0.0100	0.0050							
Jul	0.0011	0.0002	0.0033	0.0029	0.0021	0.0071						
Aug	0.0036	0.0045	0.0081	0.0077	0.0027	0.0023	0.0047					
Sep	0.0041	0.0050	0.0086	0.0082	0.0032	0.0018	0.0053	0.0005				
Oct	0.0026	0.0017	0.0019	0.0015	0.0035	0.0085	0.0014	0.0062	0.0067			
Nov	0.0010	0.0019	0.0055	0.0051	0.0001	0.0049	0.0022	0.0026	0.0031	0.0036		
Dec	0.0075	0.0084	0.0120	0.0116	0.0066	0.0016	0.0086	0.0039	0.0034	0.0101	0.0065	

Critical S 5%	Jan & Non Jan	0.024	**Critical S 5%**	Non Jan & Non Jan	0.024
Critical S 10%	Jan & Non Jan	0.023	**Critical S 10%**	Non Jan & Non Jan	0.022

Appendix E.5.18: Contrasts between Mean Calendar Month Payoffs to MOM-6

MOM-6	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0007											
Mar	0.0032	0.0026										
Apr	0.0045	0.0039	0.0013									
May	0.0001	0.0006	0.0032	0.0045								
Jun	0.0036	0.0043	0.0069	0.0082	0.0037							
Jul	0.0019	0.0012	0.0013	0.0026	0.0018	0.0055						
Aug	0.0001	0.0005	0.0031	0.0044	0.0000	0.0037	0.0018					
Sep	0.0011	0.0018	0.0044	0.0057	0.0012	0.0025	0.0030	0.0013				
Oct	0.0054	0.0047	0.0021	0.0008	0.0053	0.0090	0.0035	0.0053	0.0065			
Nov	0.0022	0.0016	0.0010	0.0023	0.0021	0.0058	0.0003	0.0021	0.0034	0.0031		
Dec	0.0074	0.0081	0.0107	0.0120	0.0075	0.0038	0.0093	0.0075	0.0063	0.0128	0.0096	

Critical S 5%	Jan & Non Jan	0.028	**Critical S 5%**	Non Jan & Non Jan	0.027
Critical S 10%	Jan & Non Jan	0.026	**Critical S 10%**	Non Jan & Non Jan	0.025

Appendix E.5.19: Contrasts between Mean Calendar Month Payoffs to MOM-12

MOM-12	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0022											
Mar	0.0056	0.0034										
Apr	0.0087	0.0065	0.0031									
May	0.0010	0.0012	0.0046	0.0077								
Jun	0.0037	0.0059	0.0093	0.0124	0.0047							
Jul	0.0024	0.0002	0.0032	0.0063	0.0014	0.0061						
Aug	0.0007	0.0015	0.0049	0.0080	0.0003	0.0044	0.0017					
Sep	0.0006	0.0027	0.0061	0.0092	0.0016	0.0032	0.0029	0.0013				
Oct	0.0026	0.0004	0.0030	0.0061	0.0016	0.0063	0.0002	0.0019	0.0031			
Nov	0.0034	0.0012	0.0022	0.0053	0.0024	0.0071	0.0010	0.0027	0.0039	0.0008		
Dec	0.0059	0.0081	0.0115	0.0146	0.0069	0.0022	0.0083	0.0066	0.0054	0.0085	0.0093	

Critical S 5%	Jan & Non Jan	0.027	**Critical S 5%**	Non Jan & Non Jan	0.026
Critical S 10%	Jan & Non Jan	0.025	**Critical S 10%**	Non Jan & Non Jan	0.024

Appendix E.5.20: Contrasts between Mean Calendar Month Payoffs to MOM-18

MOM-18	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan												
Feb	0.0021											
Mar	0.0050	0.0071										
Apr	0.0077	0.0099	0.0027									
May	0.0014	0.0007	0.0064	0.0091								
Jun	0.0063	0.0042	0.0113	0.0141	0.0049							
Jul	0.0032	0.0011	0.0082	0.0109	0.0018	0.0031						
Aug	0.0043	0.0022	0.0093	0.0120	0.0029	0.0020	0.0011					
Sep	0.0054	0.0033	0.0104	0.0131	0.0040	0.0009	0.0022	0.0011				
Oct	0.0029	0.0050	0.0021	0.0048	0.0043	0.0092	0.0061	0.0072	0.0083			
Nov	0.0009	0.0030	0.0041	0.0068	0.0023	0.0072	0.0041	0.0052	0.0063	0.0020		
Dec	0.0077	0.0056	0.0127	0.0155	0.0063	0.0014	0.0045	0.0034	0.0023	0.0106	0.0086	

Critical S 5%	Jan & Non Jan	0.025	**Critical S 5%**	Non Jan & Non Jan	0.025
Critical S 10%	Jan & Non Jan	0.024	**Critical S 10%**	Non Jan & Non Jan	0.023

Appendix F

Appendix F contains material associated with chapter 9: Multivariate Sector-Specific Attribute Analysis.

Appendix F.1: Stepwise Results for the Trailing Historic Mean Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal historic mean (HIST) model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes		Five Attributes		Six Attributes		Seven Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.015	0.173	0.075	0.483	0.080	0.537	0.081	0.558	0.081	0.553	0.082	0.536	0.081	0.526
DY	0.035	0.448	**0.080**	0.574										
C-6P	0.023	0.358	0.067	0.430	0.078	0.517	0.079	0.543	0.079	0.542	0.078	0.515	0.078	0.504
C-12P	0.026	0.358	0.068	0.424	0.078	0.515	0.079	0.541	0.079	0.541	0.080	0.523	0.080	0.513
CB	0.022	0.305	0.070	0.445	0.080	0.527	**0.081**	0.558						
D-12P	0.023	0.354	0.068	0.458	0.078	0.557	0.078	0.564	0.080	0.543	0.081	0.530	0.081	0.520
D-24P	0.021	0.317	0.066	0.439	0.076	0.525	0.076	0.529	0.078	0.511	0.080	0.497	0.080	0.491
PO	0.017	0.287	0.071	0.494	**0.080**	0.581								
ROE	0.020	0.316	0.069	0.429	0.077	0.497	0.079	0.521	0.081	0.548	**0.083**	0.536		
MOM-1	0.023	0.202	0.067	0.454	0.079	0.579	0.079	0.579	0.079	0.546	0.079	0.525	0.079	0.522
MOM-3	0.036	0.266	0.066	0.433	0.079	0.557	0.078	0.558	0.081	0.549	0.079	0.518	0.079	0.516
MOM-6	0.062	0.410	0.069	0.453	0.080	0.563	0.080	0.567	**0.082**	0.540				
MOM-12	**0.069**	0.467												

Appendix F.2: Stepwise Results for the MA-6 Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal 6-month moving average (MA-6) model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.012	0.137	0.077	0.559	**0.085**	0.622		
DY	0.031	0.383	**0.082**	0.610				
C-6P	0.018	0.294	0.057	0.384	0.078	0.575	0.083	0.606
C-12P	0.026	0.384	0.055	0.366	0.078	0.576	0.081	0.606
CB	0.025	0.354	0.061	0.411	0.078	0.555	0.084	0.601
D-12P	0.011	0.152	0.058	0.409	0.077	0.580	0.080	0.583
D-24P	0.020	0.298	0.065	0.458	0.081	0.610	0.081	0.583
PO	0.016	0.277	0.067	0.511	0.082	0.650	0.084	0.617
ROE	0.017	0.263	0.068	0.455	0.082	0.582	0.085	0.600
MOM-1	0.016	0.133	0.043	0.297	0.070	0.541	0.071	0.515
MOM-3	0.017	0.120	0.048	0.330	0.068	0.497	0.072	0.469
MOM-6	0.027	0.165	0.047	0.280	0.061	0.380	0.070	0.428
MOM-12	**0.067**	0.431						

Appendix F.3: Stepwise Results for the MA-12 Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal 12-month moving average (MA-12) model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.002	0.023	0.073	0.454	0.079	0.494	0.077	0.486
DY	0.026	0.325	**0.075**	0.502				
C-6P	0.019	0.295	0.066	0.393	**0.080**	0.506		
C-12P	0.026	0.371	0.064	0.392	0.079	0.518	0.076	0.507
CB	0.016	0.220	0.063	0.370	0.076	0.472	0.076	0.490
D-12P	0.011	0.155	0.066	0.421	0.073	0.490	0.075	0.477
D-24P	0.018	0.262	0.063	0.406	0.071	0.485	0.072	0.466
PO	0.005	0.087	0.061	0.412	0.076	0.519	0.078	0.513
ROE	0.023	0.357	0.062	0.376	0.078	0.507	0.078	0.490
MOM-1	0.009	0.078	0.049	0.310	0.068	0.456	0.069	0.427
MOM-3	0.032	0.223	0.055	0.376	0.071	0.515	0.072	0.478
MOM-6	**0.067**	0.423						
MOM-12	0.063	0.402	0.057	0.356	0.077	0.521	0.076	0.458

Appendix F.4: Stepwise Results for the MA-18 Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal 18-month moving average (MA-18) model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes		Five Attributes		Six Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.009	0.107	**0.082**	0.493								
DY	0.024	0.293	0.081	0.529	**0.084**	0.497						
C-6P	0.019	0.301	0.070	0.402	0.077	0.464	0.081	0.483	0.084	0.480	0.083	0.498
C-12P	0.027	0.370	0.073	0.416	0.076	0.469	0.080	0.493	0.081	0.472	0.082	0.500
CB	0.008	0.104	0.071	0.412	0.078	0.467	0.080	0.482	0.083	0.477	0.084	0.503
D-12P	0.016	0.229	0.072	0.436	0.078	0.467	0.081	0.477	0.082	0.468	0.084	0.500
D-24P	0.013	0.187	0.071	0.437	0.076	0.455	0.078	0.464	0.079	0.446	0.081	0.478
PO	0.009	0.141	0.069	0.444	0.079	0.500	0.083	0.511	**0.086**	0.515		
ROE	0.018	0.280	0.070	0.422	0.077	0.460	0.082	0.486	0.081	0.461	0.083	0.484
MOM-1	0.015	0.122	0.064	0.393	0.076	0.456	0.079	0.473	0.082	0.471	0.082	0.493
MOM-3	0.046	0.316	0.060	0.374	0.069	0.420	0.073	0.441	0.078	0.458	0.078	0.482
MOM-6	**0.074**	0.454										
MOM-12	0.049	0.291	0.073	0.433	0.080	0.456	**0.085**	0.488				

Appendix F.5: Stepwise Results for the Single Exponential Smoothing Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal single exponential smoothing (S-EXP) model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes		Five Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.016	0.180	0.077	0.509	0.083	0.553	0.083	0.542	0.082	0.548
DY	0.026	0.327	**0.080**	0.581						
C-6P	0.025	0.389	0.069	0.445	0.080	0.535	0.081	0.525	0.080	0.525
C-12P	0.030	0.435	0.070	0.442	0.081	0.537	0.081	0.523	0.080	0.515
CB	0.015	0.211	0.071	0.448	0.082	0.530	0.083	0.534	0.081	0.525
D-12P	0.023	0.354	0.069	0.461	0.079	0.569	0.079	0.558	0.080	0.565
D-24P	0.028	0.424	0.069	0.450	0.077	0.532	0.077	0.524	0.078	0.530
PO	0.017	0.287	0.073	0.505	0.078	0.567	0.078	0.549	0.080	0.579
ROE	0.020	0.316	0.070	0.435	0.080	0.516	0.080	0.513	0.079	0.512
MOM-1	0.029	0.252	0.071	0.474	0.083	0.597	**0.086**	0.611		
MOM-3	0.038	0.275	0.069	0.452	**0.085**	0.603				
MOM-6	0.062	0.410	0.072	0.478	0.083	0.580	0.080	0.561	0.080	0.560
MOM-12	**0.069**	0.467								

Appendix F.6: Stepwise Results for the Double Exponential Smoothing Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal double exponential smoothing (D-EXP) model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes		Five Attributes		Six Attributes		Seven Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.024	0.286	**0.080**	0.546	**0.085**	0.579	**0.090**	0.557						
DY	0.025	0.302	**0.080**	**0.583**										
C-6P	0.025	0.389	0.065	0.435	0.080	0.555	0.086	0.532	0.088	0.547	0.089	0.579	0.089	0.580
C-12P	0.030	0.435	0.069	0.440	0.082	0.556	0.087	0.537	0.089	0.554	**0.091**	**0.594**		
CB	0.022	0.305	0.070	0.441	0.081	0.536	0.087	0.537	0.089	0.549	0.089	0.583	0.089	0.578
D-12P	0.020	0.297	0.068	0.462	0.078	0.566	0.084	0.573	0.088	0.542	0.089	0.586	0.089	0.588
D-24P	0.012	0.166	0.067	0.441	0.076	0.530	0.082	0.545	0.086	0.523	0.087	0.560	0.089	0.574
PO	0.017	0.287	0.073	0.512	0.079	0.600	0.084	0.594	**0.091**	0.591				
ROE	0.013	0.197	0.067	0.423	0.079	0.536	0.086	0.552	0.088	0.538	0.090	0.571	0.091	0.588
MOM-1	0.022	0.187	0.067	0.449	0.081	0.595	0.085	0.590	0.088	0.555	0.089	0.587	0.089	0.586
MOM-3	0.038	0.275	0.064	0.432	0.079	0.565	0.078	0.572	0.084	0.556	0.084	0.591	0.083	0.614
MOM-6	0.062	0.410	0.075	0.489	**0.085**	**0.584**								
MOM-12	**0.069**	**0.467**												

Appendix F.7: Stepwise Results for the Holt-Winters Exponential Smoothing Forecasting Model

The table shows the mean monthly Information Coefficient (IC) and mean Information Ratio (IR) for each attribute at each stage of the stepwise procedure (described in section 9.2.3.1) used to derive the stepwise optimal Holt-Winters (H-W) exponential smoothing model. Monthly forecasts are made over the in-sample period from 31 January 1995 to 31 December 2001. The attributes under consideration are those that produce significant payoffs at the 5% level in the univariate cross-sectional regression analyses of chapter 6, over the in-sample period. The highest IC at each step is shown in bold font. Where two attributes exhibit the same highest IC, the higher IR for the two attributes is displayed in bold font. The data was obtained from Datastream International at the University of Cape Town. Full definitions of the sector-specific attributes are given in table 4.1.

	One Attribute		Two Attributes		Three Attributes		Four Attributes	
Attribute	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio	Mean Information Coefficient	Mean Information Ratio
CP	0.022	0.261	0.080	0.573	**0.085**	**0.594**		
DY	0.026	0.323	**0.081**	**0.617**				
C-6P	0.020	0.308	0.056	0.375	0.080	0.571	0.083	0.594
C-12P	0.030	0.435	0.067	0.437	0.081	0.563	0.083	0.598
CB	0.015	0.211	0.067	0.437	0.078	0.542	0.073	0.523
D-12P	0.017	0.252	0.058	0.413	0.078	0.605	0.078	0.559
D-24P	0.020	0.297	0.055	0.372	0.074	0.543	0.078	0.539
PO	0.017	0.279	0.065	0.477	0.079	0.613	0.084	0.619
ROE	0.013	0.194	0.049	0.317	0.077	0.561	0.080	0.555
MOM-1	0.009	0.074	0.053	0.365	0.075	0.588	0.078	0.586
MOM-3	0.038	0.275	0.063	0.418	0.082	0.586	0.081	0.540
MOM-6	0.062	0.410	0.061	0.402	0.076	0.547	0.081	0.542
MOM-12	**0.065**	**0.434**						